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THESIS

DESIGNING AND PREPOSITIONING HUMANITARIAN ASSISTANCE PACK-UP KITS (HA PUKs) TO SUPPORT PACIFIC FLEET EMERGENCY RELIEF OPERATIONS

by

Valerie M. McCall

December 2006

Thesis Advisor:	Gerald G. Brown
Second Reader:	Steven Pilnick

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DESIGNING AND PREPOSITIONING HUMANITARIAN ASSISTANCE PACK-UP KITS (HA PUKs) TO SUPPORT PACIFIC FLEET EMERGENCY RELIEF OPERATIONS

Valerie M. McCall
Lieutenant, United States Navy
B.S., University of Massachusetts, Dartmouth, 1995
M.B.A., National University, 2004

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requirements for the degree of

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NAVAL POSTGRADUATE SCHOOL
December 2006

Author: Valerie M. McCall

Approved by: Gerald G. Brown
Thesis Advisor

Steven Pilnick
Second Reader

James N. Eagle
Chairman, Department of Operations Research

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ABSTRACT

The 2006 Quadrennial Defense Review has emphasized the role of humanitarian assistance missions in winning the Global War on Terror. U.S. Pacific Fleet operates in an area prone to both terrorist recruitment and sudden-onset natural disasters that require humanitarian assistance and disaster relief operations. The U.S. Navy has unique capabilities to deliver first-response humanitarian assistance. This thesis develops and suggests pre-positions for humanitarian assistance pack-up kits that contain emergency relief material commonly used in these missions in order to expedite delivery to those impacted by a disaster.

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LIST OF ACRONYMS AND ABBREVIATIONS

ADPC	Asian Disaster Preparedness Center
APAN	Asia-Pacific Area Network
APOD	Aerial Port of Debarkation
COMLOGWESTPAC	Commander, Logistics Group Western Pacific
CONUS	Continental United States
DDC	Defense Distribution Center
DLA	Defense Logistics Agency
DoD	Department of Defense
DR	Disaster Relief
ESG	Expeditionary Strike Group
FHA	Foreign Humanitarian Assistance
FISC	Fleet and Industrial Supply Center
FOL	Follow-on Latrine
GAMS	Generalized Algebraic Modeling System
HA	Humanitarian Assistance Disaster Relief
HDR	Humanitarian Daily Ration
ICRC	International Committee of the Red Cross
MIDL	Modular Initial Deployment Latrine
MOOTW	Military Operation Other Than War
MPSRON	Maritime Prepositioning Squadron
MTL	Maturing Theater Latrine
NGO	Non-government Organization
OFDA	Office of United States Foreign Disaster Assistance
PUK	Pack-up Kit
QDR	Quadrennial Defense Review
SPOD	Sea Port of Debarkation
TPFFD	Time-Phased Force and Deployment Data
TWPS	Tactical Water Purification System
USAID	United States Agency for International Development
USPACFLT	United States Pacific Fleet
USPACOM	United States Pacific Command
USTRANSCOM	United States Transportation Command
WMD	Weapons of Mass Destruction

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EXECUTIVE SUMMARY

The U.S. military has historically been called upon to perform humanitarian assistance and disaster relief missions. These operations continue to gain attention and importance in the War on Terror. The U.S. Armed Forces provide an instantly recognizable demonstration of the goodwill of the American people. This representation makes a difference in changing the perception of the United States and helping to prevent terrorist recruitment.

U.S. Pacific Command’s area of operation is home to nearly sixty percent of the world’s population and experiences fifty percent of total world disasters. The region covers over 105 million square miles and the tyranny of distance creates a logistics challenge even for routine operations. Time-critical operations, such as in the acute phase of response to a disaster, make it even more crucial to have an understanding of the logistics requirements before the need arises.

The United States Navy has unique capabilities to provide immediate aid to reduce suffering after a disaster while other relief agencies and nations organize and prepare to enter the region. The effectiveness of these capabilities diminishes as time passes, taking a toll on lives and human suffering. A pre-positioned pack-up kit of first-response material can be immediately deployed, takes the guesswork out of initial requirements and helps capitalize on the Navy’s unique ability to arrive on scene quickly.

This thesis identifies the relief material necessary to meet the immediate requirements of a population

regardless of the type and location of the disaster. Logistics planning factors for each item are developed based upon the minimum standards in disaster response established by the Sphere Project, a humanitarian charter between hundreds of Non-Government Organizations and the Red Cross and Red Crescent, created to improve the quality of assistance provided to people affected by disasters. The 2004 Project Sphere Handbook outlines the minimum standards in disaster assistance promulgated by this collaboration. These standards are used because they more accurately represent the needs of a civilian population suffering after a natural disaster than traditional military planning factors.

Once the necessary items and appropriate planning factors are identified, we construct two versions of the pack-up kit: hot and cold weather-specific. Each kit contains climate-appropriate material to support 1,000 people for 14 days.

We introduce an optimization model to prescribe pre-positioning pack-up kits in various candidate locations given budget and space limitations. The model is formulated to minimize “victim-nautical-miles” to transport the material to each potential disaster location. It also determines the number of each version of the pack-up kit to procure and the optimal location(s) for them for a given budget.

We conclude that Singapore is the single best storage location for disaster relief pack-up kits. In addition, Osan, Republic of Korea, is the best location to store cold-weather pack-up kits. Guam and Yokota, Japan, can also be used, but the impact is increased response time.

I. INTRODUCTION

A. BACKGROUND

The U.S. military has historically provided assistance to victims of natural disasters. This role will grow and gain importance as we try to win the "hearts and minds" of the world in our campaign against terrorism. The 2006 Quadrennial Defense Review emphasizes the importance of humanitarian assistance (HA) and disaster relief (DR) operations in today's world:

> By alleviating suffering and dealing with crises in their early stages, U.S. forces help prevent disorder from spiraling into wider conflict or crisis. They also demonstrate the goodwill and compassion of the United States. [DoD QDR 2006, p. 12]

U.S. Pacific Command (USPACOM) operates in an area that covers 105 million square miles. This region is home to 60% of the world's population and 20% of its land area [USPACOM, 2006]. In addition, the United Nations International Strategy for Disaster Reduction (2006) states that over 50% of total world disasters occur in the Asia Pacific region. Disasters here tend to have devastating consequences because regional populations are extremely vulnerable due to a variety of socio-economic factors.

U.S. Pacific Fleet (USPACFLT) is regularly called upon to conduct humanitarian assistance operations in Southeast Asia. These missions are complicated by the wide range of disasters afflicting the region. Asia and the Pacific Islands are prone to typhoons, tsunamis, floods, earthquakes, volcanic eruption and other natural hazards [UN ISDR, 2006]. These events are unpredictable and require a unique and timely response to save lives.

B. THESIS MOTIVATION

Lessons learned submissions from prior HA missions often cite that requirements are not known and that standardization of HA items would be beneficial. The International Committee of the Red Cross and the Red Crescent (ICRC) has created kits of HA material for immediate response situations. According to their website:

> Large-scale operations in various contexts worldwide are not always compatible with individual tailored response due to the urgency of the requests and needs. This is particularly true in emergency situations. Indeed, in the immediate emergency it might be impossible to determine and analyse demand: no records, no time for an in depth assessment. Although these situations where reactivity is of great importance differ, certain needs that frequently arise can be identified. The kit policy intention is to fulfil these needs in these situations by providing pre-packed, immediately available sets of material whilst guaranteeing the best possible use of human and economic resources. [ICRC, 2004, Vol. 3]

Standardization of relief material can improve the Navy's ability to provide the rapid emergency response critical to sustaining life after a disaster. This allows U.S. Forces to capitalize on their ability to conduct operations in austere locations where delivery and offload facilities are damaged or inadequate [JCS, 2001, p. IV-6].

The U.S. Navy has unique capabilities beneficial to conducting first-responder humanitarian missions. Naval forces arrive with critical mass quickly, commence relief support immediately upon arrival and can sustain those operations indefinitely. The Navy does not rely upon shore infrastructure and can conduct command and control functions solely from the sea. Minimizing presence ashore decreases force protection concerns and avoids a large build up of U.S. forces and material ashore. Naval forces are also flexible and can adapt quickly to a change in force protection level or change in the environment [CNO, 2006, p. A-3].

Quick response is key. As time passes, the cost is lives lost. Since logistic requirements are not always clearly defined, units deploying to support the mission assemble their "best guess" of the supplies they require to hasten their arrival to the mission area. This approach allows personnel to arrive in the area quickly but results in disorganization and a large amount of unnecessary material in the region.

The Joint Chiefs of Staff Joint Doctrine for Military Operations Other Than War (MOOTW) Joint Pub 3-07 [1995] states that materials required in humanitarian assistance operations are often used in quantities disproportionate to their standard military use. This does not mean the answer is to procure large amounts of materials perceived to be beneficial. This is counterproductive as it creates a large footprint of materials that may or may not be used in the operation. Benefits that the Navy provides are diminished when inadequate or improper disaster relief materials are procured. A standard HA pack-up kit (PUK) that can be put in use while additional requirements are determined will allow the Navy to respond quickly with essential life-sustaining supplies. This kit can then be pre-positioned in a way that minimizes the time required to transport it where it is needed.

C. THESIS OBJECTIVES

Disasters are unpredictable, but we know they will happen. Knowing that we will be called upon to perform HA missions at some future time, it is important that we examine our logistics and identify materials essential to all such missions. Creating an HA PUK that contains a baseline of appropriate response materials to meet the minimum life-sustaining requirements of a population suffering after any type of disaster would expedite the arrival of these essential items into the disaster area. Supplemental items can be brought to the area once the unique requirements of the disaster have been assessed.

Pre-positioning these PUKs will allow faster access to the materials. Having a PUK pre-assembled and ready to ship takes the guesswork out of determining mission requirements. Additionally, the PUK can be used to plan a Time-Phased Force and Deployment Data (TPFDD) submission to U.S. Transportation Command's (USTRANSCOM) for approval. This action estimates allocation of appropriate assets for movement.

D. THESIS ORGANIZATION

The remainder of this thesis is organized as follows: Chapter II provides an historic perspective of the deployment of naval forces for HA/DR missions in Southeast Asia. Additionally, Chapter II discusses the vulnerability of the region to disasters and the types of military foreign humanitarian assistance missions. Chapter III presents the assumptions, logistic planning factors, positioning model formulation and analysis. Finally, Chapter IV contains concluding remarks and recommendations for future study in naval humanitarian assistance operations. Appendix A lists the countries under USPACOM's cognizance. Appendix B provides birth rate data for determining the amount of infant supplies required for the PUK. Appendix C contains the contents of the hot and cold-weather PUKs.

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II. HUMANITARIAN ASSISTANCE CONSIDERATIONS FOR THE ASIA PACIFIC REGION

A. HISTORICAL PERSPECTIVE

The history of humanitarian assistance operations conducted in Asia, the Pacific Islands and surrounding areas in recent years demonstrates the vulnerability of the region to disasters. Reviewing recent operations provides insight into the types of humanitarian operations the Navy has participated in and supports an analysis of the similarities and differences of each disaster.

To develop an effective PUK, it is necessary to look at operations covering the full range of disasters in the region. These past operations show the level of destruction inflicted and how the Navy has provided aid to the people.

1. Operation Unified Assistance, 2004

On December 26th 2004, an undersea earthquake with a magnitude of 9.0 unleashed a deadly tsunami, which killed over 275,000 people and left another 1.1 million people in Indonesia, Thailand, Sri Lanka and India without homes [Dorsett, 2005, p.12].

Human activities are thought to have contributed to the devastation inflicted by the tsunami. Many coral reefs in the Indian Ocean have been destroyed because they are considered a hindrance to economic progress. Similarly, the removal of mangrove trees and sand dunes in many areas has left the land vulnerable to the full impact of the tsunami. [Wikipedia, 2006]

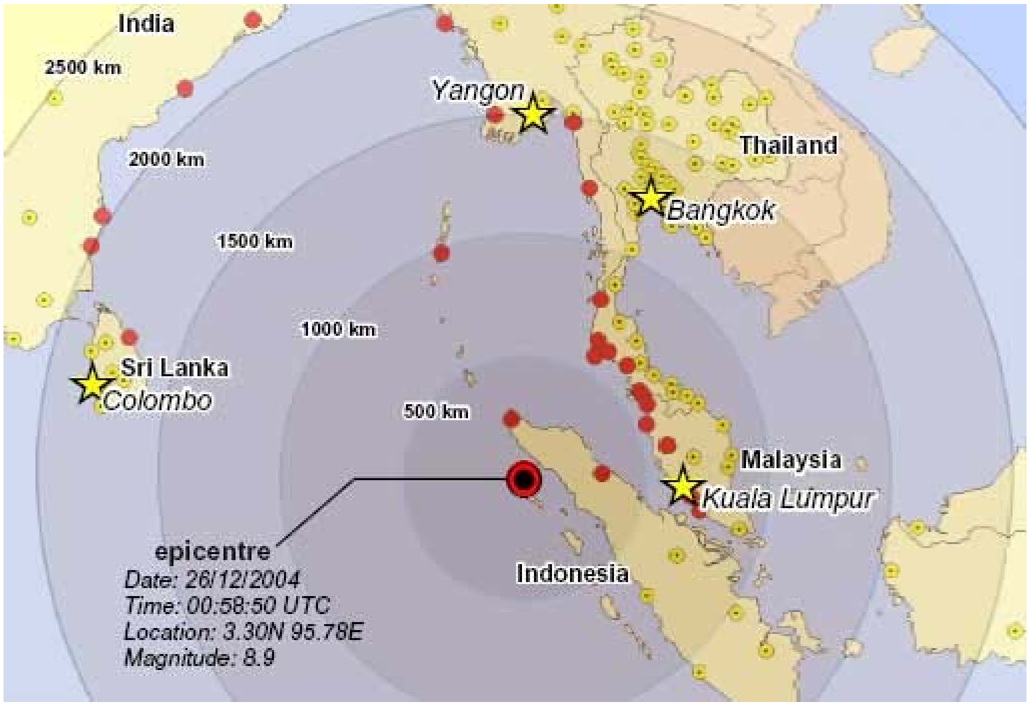

Figure 1: Undersea Earthquake Causing the 2005 Tsunami [From Wikipedia, 2006].

The U.S. Navy provided most of its assistance during the first six weeks after the tsunami. Two days after the initial devastation, Joint Task Force 536, which later became Combined Support Force (CSF 536), was established to "provide assistance to the governments of Indonesia, Sri Lanka, Thailand, and other nations to mitigate the effects of the recent earthquake and tsunami in the Indian Ocean" [Emerald Express 06-01, 2006, p.4]. Naval contributions to Operation Unified Assistance listed in Emerald Express 06-01 [2006] include:

- U.S. Navy ships from the USS Abraham Lincoln Carrier Strike Group and USS Bon Homme Richard Expeditionary Strike Group, which delivered a combined total of over 24.5 million pounds of supplies;
- Six ships from the Maritime Preposition Squadron (MPSRON) 3 in Guam deployed to produce and deliver potable water; and
- USNS Mercy conducted Humanitarian Assistance Operations until mid-March.

The U.S. military provided relief of immediate suffering, lent support to the host nation and U.S. AID and allowed civil relief organizations time to organize their long-term response efforts [Emerald Express 06-01, 2006, p.5].

2. Operation Lifeline, 2005

On October 8, 2005, a major earthquake measuring 7.6 on the moment magnitude scale hit the Kashmir region of Pakistan [World Almanac and Book of Facts, 2005]. While Pakistan is not located in U.S. Pacific Command's (USPACOM's) area of responsibility, the earthquake could just have easily occurred in India or other surrounding regions within USPACOM's reach. The earthquake killed over 73,000 people and left 3.5 million people homeless [UN OCHA, 2006]. A contributing factor to the level of damage inflicted was that buildings in the region had poor earthquake resilience [United Nations, 2005].

Figure 2: Pakistan Earthquake 2005 [From RDML LeFevre Brief, 2006].

The American military led the international relief effort. The first Americans were in country surveying the area within 48 hours of the event and the first U.S. helicopters were airlifting supplies within 72 hours [Garamone, 2006].

3. Philippines Mudslide, 2006

Two weeks of heavy rain caused a mountain side to suddenly collapse in Leyte, Philippines, on February 17, 2006. The collapse was blamed on past logging and mining activities that destabilized the region.

Figure 3: Source and Aerial Extent of the Mudslide [From Huggler, 2006]. The area at the foot of the mountains was once the village of Guinsaugon, which is now unrecognizable under a blanket of mud. Excessive rains caused a massive mudslide that engulfed the entire village. Over 30 feet of mud completely covered the 1.2 square mile area, trapping over 1,000 people [Huggler, 2006].

The Forward-Deployed Expeditionary Strike Group (ESG) with elements of the 31st Marine Expeditionary Unit and Joint Task Force Balikatan had just arrived in the area for the bilateral exercise Balikatan 06. The forces were redirected to the relief effort in Leyte [Sisk, 2006]. Because the ESG was already in the area, they were able to begin relief efforts within 48 hours of the disaster. Numerous relief supply delivery sorties were conducted by the embarked Marine Medium Helicopter Squadron (HMM-262). Additionally, about 200 marines immediately joined in the search and rescue effort using shovels because the mud was too soft to support heavy machinery [Sisk, 2006].

B. DISASTER CLASSIFICATION

According to the United Nations International Strategy for Disaster Reduction [2006], a disaster is defined to be an unforeseen and often sudden event that causes great damage, destruction and human suffering that overwhelms local capacity, necessitating a request to the national or international level for external assistance. Disasters can be separated into two major categories: “acts of God” (or natural disasters) and “acts of man” (also known as technological disasters).

Natural disasters can be further split into three groups [UN ISDR, 2006]:

- **Hydro-meteorological disasters:** floods and wave surges, storms, droughts and related disasters (extreme temperatures and forest/scrub fires), landslides and avalanches;
- **Geophysical disasters:** earthquakes, tsunamis and volcanic eruptions; and
- **Biological disasters:** epidemics and insect infestations.

A manmade, or technological disaster, is an event that brings on a major crisis, causes massive loss of life and property and may endanger the environment in which it occurs. Technological disasters include industrial accidents (chemical spills, gas leaks, and radiation), transport accidents and other miscellaneous accidents such as explosions and fires that are not caused by nature. An example of a technological disaster is the 1986 Chernobyl nuclear reactor explosion [Evan & Manion, 2002].

1. Disasters in the Asia and Pacific Islands Region

Asia and the Pacific Islands suffer more natural disasters than any other area of the world [UNEP, 2001]. Most major natural disasters occur due to climactic and seismic factors. The majority of the region is located on the Ring of Fire, a zone of frequent earthquakes and volcanic eruptions that encircles the basin of the Pacific Ocean [Kious & Tilling, 1996, p. 39]. The Ring of Fire is a horseshoe-shaped region approximately 40,000 km long associated with a nearly continuous series of oceanic trenches, island arcs, and volcanic mountain ranges and/or plate movements. Eighty-one percent of the world's largest earthquakes occur along the Ring of Fire [U.S. Geological Survey, 2006]. The Asia-Pacific region has recorded over 70% of the world’s earthquakes that measure 7 or more on the Richter scale and experiences an average of 15 events each year [UNEP, 2001]. Another hazard associated with the Ring of Fire is elevated levels of volcanic activity.

In addition to geologic hazards, the Asia Pacific region has a broad range of climate and geographic features, making the region susceptible to a wider range of meteorological disasters [Preston, et al., 2006, p. 13]. Nations north of 30˚N latitude (such as China and the Himalaya Mountains) can experience temperatures at or below freezing and have significant seasonal temperature changes [Preston, et al., 2006, p. 12]. Regions to the south experience temperatures above 25˚C year-round. A view of average seasonal temperatures over a 30-year period is shown in Figure 4.

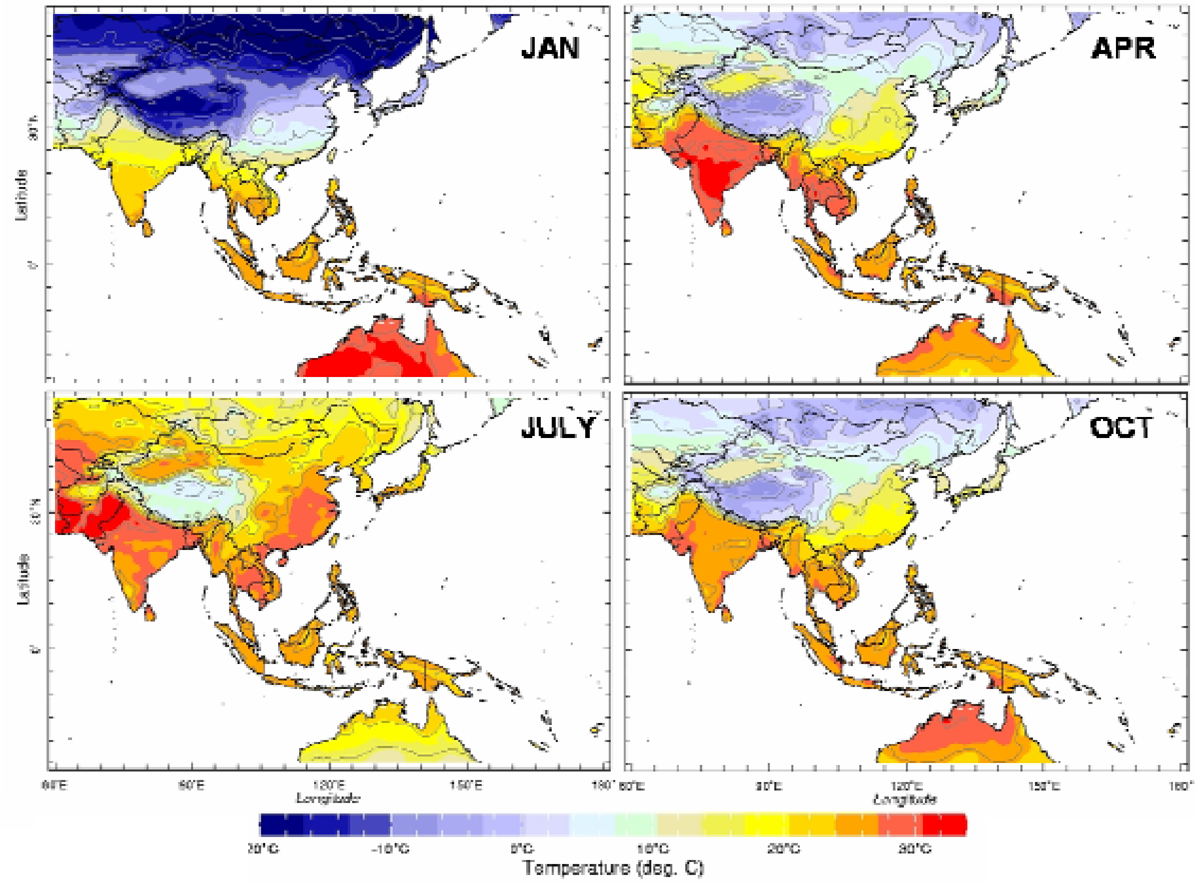

Figure 4: Average Seasonal Temperatures across the Asia Pacific Region (1961 – 1990) [From Preston, et al., 2006]. This figure depicts the extreme temperature variations in the Asia Pacific Region. For example, in January, temperatures throughout the region range from -20°C to +30°C. U.S. Pacific Command must be prepared to conduct humanitarian assistance operations in a variety of climates.

Each geographic region has different characteristics that contribute to the type of natural disasters that occur in the area. Additionally, various seasons and the associated climate changes (temperatures) impact the affected population's requirements after a disaster.

Asia and Pacific Islands are regularly subjected to meteorological catastrophes. The vast Pacific Ocean is a natural catalyst for powerful cyclonic systems. Every few years, a phenomenon known as El Niño amplifies these climatic events through the influence of unusually warm ocean temperatures [Shwartz, 2001].

Meteorological catastrophes impact the region in several ways. Flooding is the most common climate-related disaster in the region. Floods occur for various reasons including seasonal flooding, flash floods, urban flooding due to inadequate drainage and typhoon-induced flooding [UNEP, 2001]. Aside from flooding, storms also cause devastation with their high winds and tidal surges.

In addition to being more likely to experience a disaster, nations in this region are particularly vulnerable to these disasters. Figure 5 lists some of the factors the United Nations has identified that contribute to the progression of disaster vulnerability. Population growth, widespread poverty, environmental degradation, increasing pollution and unplanned human settlements increase the vulnerability of an area to disaster. These factors create a favorable terrain for natural hazards to transform into devastating disasters that result in large death tolls and disrupted human lives and economic means [UN ISDR, 2006].

Marine resources, such as fishing and tourism, are very important parts of the regional population's livelihood. Environmental degradation of the region is pronounced, and it has stripped away many of the natural defenses against disasters such as typhoons and flooding. This was demonstrated by the level of destruction inflicted by the 2004 tsunami. Coral reefs have been removed to clear shipping lanes and cater to tourists while mangrove trees have been uprooted to build homes and hotels, effectively removing barriers that would have slowed the rush of water.

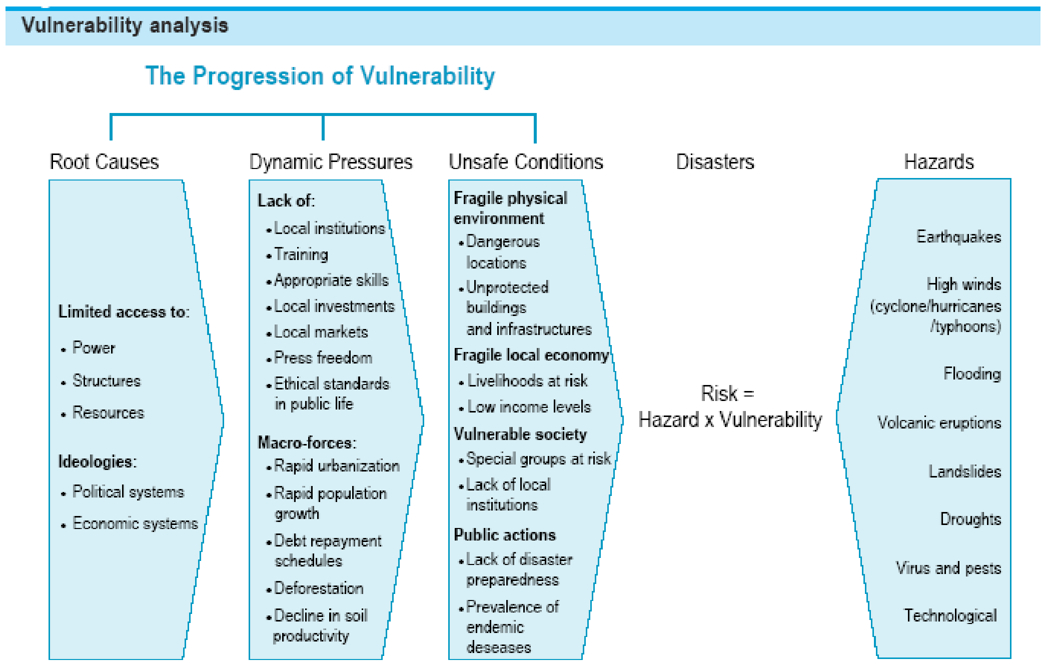

Figure 5: Indicators of Disaster Vulnerability [From Interagency Secretariat of the International Strategy for Disaster Reduction Asia and Pacific, 2004, p. 71]. This chart depicts factors that contribute to increased devastation after a disaster. A quick review of the factors reveals that many countries in Pacific Command's area of responsibility exhibit most, if not all, of these factors. The United Nations Environment Program (2001) has stated that the Asia and Pacific region's vulnerability to disasters has increased in recent years due to the aggregation of people in urban areas, environmental degradation, and a lack of disaster planning and preparedness. In addition, two out of every three people living in extreme poverty live in the Asia and Pacific Region [United Nations Population Fund, 2006].

Poverty also impacts a nation's ability to survive and recover from a natural disaster. For example, low-income countries experience approximately 3,000 deaths after an earthquake compared with less than 400 deaths in middle and high-income countries [UNEP, 2006]. This is because low-income countries do not have the resources to build critical infrastructure to withstand earthquakes and people live in crude structures that topple easily. The 2005 earthquake in Pakistan is an example of how poverty can exacerbate a disaster.

Rapid population growth in the region is also associated with increased vulnerability to natural disasters. As populations rise, they spread into regions prone to disasters [UNEP, 2006]. Population growth also impacts the environment as areas are often degraded to build homes and promote economic development.

It is not a question of “if” Pacific Command will have to provide emergency disaster relief, but rather “when” and “where.” The region experiences most of the United Nations vulnerability factors because they are interrelated. One factor is often the cause of another. PACOM’s area of operations is not only highly likely to experience a natural disaster but the population is also extremely vulnerable to its impact. Determining and pre-positioning the most critical materials can make it easier to plan and rapidly execute emergency relief operations.

2. Types of Foreign Humanitarian Assistance Missions

Military Foreign Humanitarian Assistance missions are classified as MOOTW. Joint Chiefs of Staff Joint Publication 3-07.6 Joint Tactics, Techniques, and Procedures for Foreign Humanitarian Assistance [2001] lists the following common foreign humanitarian assistance missions:

- Relief missions: immediate response to prevent loss of life and destruction of property, construction of basic sanitation facilities and shelters and provision of food and medical care.

- Dislocated civilians support: Humanitarian missions designed to support the resettlement of refugees, stateless persons, evacuees, expellees, and displaced persons. These operations are generally long-term and outside the scope of Department of Defense (DoD) sources. Tasks include camp organization, basic construction and administration, provision of care and placement of civilians. Noncombatant Evacuation Operations, which are short-term in nature and within the scope of DoD activities, also fall under this category.

- Security: Missions that establish and maintain conditions for the provision of FHA by organizations of the world-relief community. U.S. military forces may be called upon to perform this mission in the event that the host nation is unable to provide for the security of the aid workers and supplies.

- Technical assistance and support: Short-term tasks that include the restoration of communications systems, relief supply management, provision of emergency medical care, humanitarian de-mining and high priority relief supply delivery. A military example of a technical service is the use of Naval vessels to transport displaced civilians.

* Consequence management operations: Operations that mitigate the effects of man-made disasters such as the intentional or unintentional release of weapons of mass destruction, chemical, biological or radiological materials, or explosions.

The PUKs developed in this thesis are designed to support FHA relief missions.

3. COMPLICATING FACTORS TO HUMANITARIAN ASSISTANCE MISSIONS

> It is unfortunate, though often not realized, that people seldom estimate random events correctly; they always tend to remember the “exciting one” and forget the others, and as a result their opinions are nearly always unconsciously biased … Military personnel (and indeed most people without rigorous scientific training) tend to take opposite opinion of the relative validity of opinion versus facts … If science has learned one thing in the past three centuries, it is that such a point of view must be avoided if valid scientific results are to be achieved [Morse & Kimball, 1946, p. 5].

Advance planning for humanitarian missions is an arduous task due to the unpredictable occurrence of disasters. This unpredictability creates unique requirements for every disaster. There are certainly some items that can become part of a generic list based on the type of disaster, but caution must be used in its development. The same factors that make this region vulnerable to natural disasters also impact humanitarian assistance operations. Geographic location, climate, demographics, infrastructure, economic, cultural, political, and health factors are different for each disaster and must be considered before beginning operations in a region [JCS JP 3-07.6, 2001, p. x].

III. ANALYSIS

A. ASSUMPTIONS

The HA PUK is designed to support disaster relief missions being conducted to provide critical, *immediate, first-response,* life-sustaining items to a region. The next three subsections outline the assumptions used in creating the HA PUK.

1. Naval Humanitarian Assistance Operations Are Conducted in a Permissive Environment

According to the Chief of Naval Operations Naval Warfare Publication (NWP) 3-07, Naval Doctrine for MOOTW [1998], a permissive environment suffers little or no opposition or resistance to the relief operations. A permissive environment generally exists for pure relief efforts after a natural disaster where the host nation's control of the nation is not threatened. Characteristics of a permissive environment include minimal security requirements, clear objectives, host nation cooperation, participation of Non-government Organizations (NGOs) and commonality of purpose for all parties [CNO NWP 3-07, 1998, p. 3-42].

Relief operations in which naval forces operate in uncertain or hostile environments will have additional force protection and rules of engagement considerations. These PUKs will not address the needs of such operations.

2. Naval Forces Provide Relief in Response to a Sudden-Onset Natural or Man-Made Disaster

These PUKs will provide a ready source of relief materials tailored to meet the immediate requirements of disasters. The mission is short-term in scope and will end when relieved by other NGOs and agencies.

Slow-onset disasters, such as drought, are more likely to have a long-term impact on a population’s nutritional status. Relief efforts in these regions tend to be long-term and organizations have ample time to plan the operation. NGOs have the expertise required to operate in these areas and any U.S. military presence would likely be for peacekeeping missions rather than humanitarian assistance, so they are not studied in this thesis.

3. Medical Supplies in the PUKs will be Limited to Basic First-Aid Materials

There is no benefit to bringing advanced medical supplies to an area if no trained medical personnel are on scene to use them. Additionally, every disaster will have different requirements that are best assessed by medical professionals. The PUKs are designed to support life-saving medical efforts until qualified medical personnel can arrive on scene. According to the Asian Disaster Preparedness Center Post-disaster Damage Assessment & Needs Analysis Report [2000, p.15], the most common priority medical supply needs after various type of natural disasters are not medications, but items such as bandages, gauze, splints and other items found in most first-aid kits.

The World Health Organization states that the greatest demand for health services occurs within the first 24 – 48 hours after the disaster. Most injured people arrive at medical facilities during the first three to five days. A second wave of referred patients may arrive a few days after this as humanitarian operations become organized. The majority of injuries are minor cuts and bruises, a lesser number of simple fractures and a minority with serious injuries [Thieren, 1999].

Additionally, the Navy has the USNS Mercy (T-AH 19) and the USNS Comfort (T-AH 20) that can be employed for humanitarian relief. These floating ambassadors provide aid on both a psychological and physical level. The medical capabilities of other large-deck naval vessels (CVN, LHD, LHA) and the embarked medical staffs can also be called upon to provide medical assistance. These professionals can better assess the needs of the population and obtain the right vaccines, medicines and equipment. They are also qualified to administer these items and properly use the equipment.

B. LOGISTIC PLANNING FACTORS

Planning for humanitarian assistance operations is very different from planning war requirements. Military planning factors are geared towards meeting the needs of a healthy population of men aged 18 to 45. The standard planning factor for military operations is measured using pounds per man. Using this measurement, it is difficult, if not impossible, to determine the needs of the majority of the population. The needs of a population suffering after a disaster that includes pregnant and lactating women, the elderly, infants, and children is not accurately represented.

In an effort to establish minimum standards for disaster assistance, the International Red Cross and Red Crescent in conjunction with over 400 humanitarian organizations in 80 countries world-wide have joined to form a humanitarian charter called the Sphere Project. The primary goal of the Sphere Project is to identify minimum standards to be obtained in disaster assistance. The collaboration has produced a handbook that is designed for use in disaster response that is applicable in a range of situations where relief is required. Further, it is designed to meet the needs of any population (including those of both developing and developed nations) with the emphasis on meeting the urgent survival needs of people affected by disaster. The handbook is not meant to serve as an instruction manual, but instead to provide a set of indicators to be used to assess and meet the needs of the population in any situation.

It is evident that the minimum standards established by Project Sphere have been accepted and incorporated into the planning guides of major humanitarian assistance organizations, e.g., the U.S. Agency for International Development Bureau for Humanitarian Response Office of Foreign Disaster Assistance Field Operations Guide [1998]. Therefore it makes sense to use these standards when planning humanitarian assistance operations to a diverse population.

Military planning factors for humanitarian operations are examined by Sullivan [1995]. The planning factors in her thesis are developed using the traditional military planning factor of pounds per man. The majority of the planning factors she develops are best for use in long-term military humanitarian assistance operations, but a few are applicable in determining PUK quantities.

In order to ensure the PUK is versatile enough to cover the needs of enumerated possible disasters, the kit may include items not required at every disaster. To minimize this occurrence, the planner has a choice between a cold and hot weather version of the kit. In addition, there may be other disaster-specific requirements aside from those addressed by the PUK contents.

This PUK does not include assets to transport, deliver and distribute the supplies. A comprehensive transportation and distribution plan should be developed to use in conjunction with this PUK.

1. Water and Sanitation

People affected by disasters are more likely to become ill and die from diseases related to inadequate sanitation and water supplies than any other cause. Therefore, the main purposes of establishing an emergency water supply and sanitation system are to provide a minimum quantity of clean drinking water and to reduce the transmission of faeco-oral diseases. Some of the key indicators of meeting the minimum standards for water supply that are relevant to designing the PUK specified by the Sphere Project, [2004], are:

- Provide at least 15 liters of water per person per day (equivalent of 4 gallons);

- Each household has two water-collecting vessels of 10 – 20 liters, plus water storage vessels of 20 liters (both of which have narrow necks and/or covers);
- Water must be palatable;
- Water supplies at times of risk or presence of diarrhea epidemic must be treated with a residual disinfectant to an acceptable standard: residual free chlorine at the tap is 0.2-0.5 mg per liter with turbidity (silt and dirt) below 5 NTU;
- Provide 250g of soap per person per month; and
- Provide communal laundry facilities (if necessary) with 1 washing basin per 100 people with private laundering areas available for women to wash their undergarments.

The situation should be assessed to determine if adequate water is available in the region. If not, it will be necessary to find a way to provide water. There may be adequate water available that is not potable, and in this situation water treatment units will be required.

The Navy has several potential ways to provide water to a population in the worst-case scenario where the population has no access to clean water. If there is no water present in the region, ship-board capabilities could be used to produce and package water. Another option would be to distribute bottled water. Bottled water should be used only as a last resort. Many relief organizations bring bottled water to the scene and there is a tendency to over-stock. The real need is often distribution, which is better served by providing air lift and personnel assets.

If water is present but needs to be decontaminated before drinking, a new water purification known as the Tactical Water Purification System (TWPS) is replacing the old Reverse Osmosis Water Purification Unit (ROWPU). This unit is the result of a joint acquisition program with the U.S. Army serving as lead agency. This new water purification system produces up to 1,500 gallons per hour (gph) of water compared to 600 gph from the ROWPU. This water treatment system can produce potable water from fresh, brackish, salt, nuclear, biological, and chemically contaminated water sources [Roeder, 2006]. The production rates are shown in Table 1.

RAW WATER CHARACTERISTICS			POTABLE WATER PRODUCTION)
SOURCE	COMPOSITION	TEMPERATURE	
Surface water	Up to 20,000 mg/l TDS and up to 150 NTU	32 to 95° F	1500 GPH
Ground water	Up to 2500 mg/l TDS	32 to 95° F	1500 GPH
Ground water	Over 2500 mg/l TDS and up to 150 NTU	50 to 95° F	1200 GPH
Seawater	35,000 mg/l TDS	32 to 95° F	1200 GPH
Seawater	45,000 mg/l TDS	50 to 95° F	1200 GPH
Seawater	45,000 mg/l TDS	32 to 50° F	1000 GPH
Seawater	60,000 mg/l TDS	77° F	950 GPH

Table 1. Water Production Capability of the Tactical Water Purification System by Water Type [From Department of the Navy, 2004, p. 1].

The maximum output of the Tactical Water Purification System (TWPS) is 1500 gallons per hour (GPH). This rate can be achieved when using surface water or ground water with Total Dissolved Solids (TDS) such as salts or metals within the levels specified in the table. A production rate of 1200 GPH can be achieved using Ground water or Seawater within specified TDS. Turbidity (or cloudiness) of water for purification can not exceed 150 Nephelometric Turbidity Units (NTU) regardless of the water source. The TWPS can purify water from just above freezing to a maximum of 95°F, depending on the water source and composition.

The TWPS is fully self-contained (except for fuel) to perform a 5-day mission. It includes a 6,000 gallon storage and distribution system and all the associated hoses and tubes. These as well as consumables, tools and crew level repair parts are packed for mission deployment. The system can produce water within 2 hours of arrival. It is automated and only requires one person to maintain normal operation [Department of the Navy, 2004, p. 2].

The TWPS purification levels are superior to those set by the Sphere Project. It has a cold weather conversion kit so it can operate in temperatures down to 25 degrees below zero. It can operate in temperatures up to 125 degrees with 100% humidity. Additionally, it operates well even in high levels of turbidity. Assuming the minimum production of the TWPS (950 gallons) and a dispersion of 20 liters per person, one TWPS will easily produce the daily water needs for 1,000 people. It could prove daunting to try to distribute the water with only one unit. Two units would be preferable, but one would suffice.

Regardless of whether water is produced on scene or on ship, it is necessary to package the water to distribute to the people. To best meet the minimum standard water quantity per person, a collapsible 5-gallon container will be issued per person. This equates to almost 19 liters of water per container, just over the Project Sphere minimum standard.

The Sphere handbook further recounts that in most emergency situations, water-related disease is just as likely to be caused by insufficient water for personal and domestic hygiene as it is to contaminated water supplies. In order to prevent an outbreak of disease, the water supply must be protected. This must be done in conjunction with proper disposal of human excrement. Project Sphere minimum standards require convenient access to a sufficient number of comfortable, safe and hygienic toilets. Planning factors associated with meeting this goal are:

- Maximum of 20 people per toilet;
- Separate facilities for men and women in public forums;
- Easily accessible by all (including the elderly and children); and
- Easily kept clean and free of mosquito and fly breeding.

The military is very resourceful in building latrines and establishing field sanitation. Exact instructions are available in the Army Unit Field Sanitation Team Field Manual 4-25.12 [HQ Department of the Army, 2002]. Construction battalions can also be sent to the area and tasked with establishing a sanitation system. These units are self-supporting, flexible and have considerable civil engineering capabilities [CNO NWP 3-07, 1998, p. 3-39].

The Army has defined a new series for latrine support that meets a spectrum of operations [Federation of American Scientists, 2001]. Prior methods of latrine construction are now realized to be unacceptable in many situations. While construction battalions prepare to enter the region (or in a situation where they are unavailable due to operational tasking), there are new options that can be used to meet sanitation needs. These options include:

- Modular Initial Deployment Latrine (MIDL),
- Maturing Theater Latrine (MTL), and
- Follow on Latrine (FOL).

Figure 6: Modular Initial Deployment Latrine [From Army Logistician News, 1999]. The Modular Initial Deployment Latrine is compact, lightweight, easily transportable and quickly assembled.

Modular Initial Deployment Latrines (MIDLs) are designed to accompany personnel into theater at the start of operations. An MIDL consists of a privacy tent and a folding toilet that has a disposable bag that is to be removed after use and collected in a disposal unit established for this purpose. A new bag is then put in place for the next person. The unit can also be placed inside another shelter as required. It is portable, lightweight and easy to assemble.

Figure 7: Maturing Theater Latrine [From Army Logistician News, 1999]

Maturing Theater Latrines are similar to individual chemical portable toilets used at sporting events. They require waste removal capability or the waste must be burned. They are bulky and require more effort to transport into an area.

Follow-on Latrines (FOLs) are containerized basic structures and have been developed to move into a mature theater of operations. Batch laundry and shower modules are also available in separate containers. The modules have been developed in military International Organization for Standardization (ISO) containers (8′ X 8′ X 20′).

Figure 8: Follow on Latrine [From Army Logistician News, 1999]

The FOL has six stalls, is temperature controlled and easily serviceable. The military planning factor is one unit per 150 men. Restricting this factor to one unit per 120 people meets the Project Sphere minimum standard for toilets. This equates to a minimum of nine units per 1,000 people. The units could then be assigned as “male” or “female” based on the population demographics.

FOLs are relatively expensive and present a considerable burden to quickly move into the area. Since these units were designed to move into a mature theater, it is unlikely that the infrastructure to support these units will be available. The FOL should be considered for more mature humanitarian assistance operations. While the up-front cost is high, they can be disinfected and reused countless times.

The MIDL is included in the PUK. Its compact size makes it easy to transport and the unit can be assembled and ready to use quickly. It does not require specialized equipment to discard the waste. Using the Project Sphere minimum standard of one toilet to 20 people, 50 MIDLs should be sent per 1,000 people. The elderly or very sick may need assistance from relatives or a same-gender aid to avoid falling.

The shower system and batch laundry modules would also be beneficial for humanitarian use if sufficient water is available to provide these services. The minimum standard of 15 liters per person per day accounts for water required for hygiene uses such as hand-washing garments and sponge baths.

Personal hygiene products will be required regardless of the shower policy chosen. Although men and women have different product needs, one generic kit can be made that contains items required by both genders. Additionally, there will be items in the kit that should not be given to children, such as razors and deodorant. The kit should be distributed to adults only to allow them to examine the kit contents and remove inappropriate material.

The amount of feminine sanitary products required is often underestimated in disasters [McAskie, 1999]. Including them in every kit will ensure adequate supplies are made available. Having a single personal hygiene kit also assists those who must distribute the items by aggregating the items into one, easily-distributed package.

The kit should include soap, toothpaste, a toothbrush, shampoo, disposable razor(s), sanitary napkins, a towel, washcloth(s), a comb, and laundry detergent. Toilet paper is not included in the hygiene kit as each MIDL personal relief kit comes with a plastic bag, toilet paper and a moist toilette. The MIDL comes with enough plastic bags to meet the needs of 20 people for 3 days under “normal” circumstances. Additional bags will therefore be required.

Proper disposal of solid waste is also important to maintain sanitary living conditions. Project Sphere recommends that one 100-liter refuse container be allocated for every 10 families. To adequately cover personal requirements, a planning factor of one standard trash bag per person per day is used [Sullivan, 1995]. In addition, 10 extra refuse containers will be provided to meet the Project Sphere minimum standard. Depending upon the type of disaster, there may be need for additional trash bags for use in clean-up efforts. Finally, one refuse container per latrine is needed for placement outside the latrine to ensure proper disposal of the human waste. Additional solid waste disposal requirements can be determined later and procured as necessary.

Additionally, there may be a need to manage the removal of dead bodies. This is an important task that must be done with decorum and in a way that allows for the identification of the dead. In addition, care must be taken to provide protection of workers when handling the bodies. Some items suggested are [ADPC, 2000, Annex D]:

- Gloves;
- Masks (not vital, but may put workers at ease);
- Gowns;
- Body Bags;
- Identification tags;
- Pens; and
- Cameras (to photograph bodies that must be buried before identification can be made or to document the site where the body was found).

Allowing friends and relatives the opportunity to identify loved ones is important for psychological and perhaps religious reasons. Bodies should be maintained for identification purposes whenever possible. Joint Chiefs of Staff Joint Publication 4-06, Mortuary Affairs [2006a], should be consulted for specific procedures and burial rituals of various religious groups. Care should also be taken in the choice of body bag color to ensure its compliance with local cultural practice.

2. Food and Nutrition

Naval forces should focus on establishing an emergency feeding program. Emergency feeding aims to satisfy the needs of victims to sustain life and maintain good health. There are three phases in emergency feeding reflecting the stages of the situation: early, intermediate and extended emergency periods. Nutritional objectives, priority nutrients, and the food sources differ according to the period of emergency [Florentino and Bumanglag, 2002]. Our primary goal is to provide food and water in adequate amounts for temporary maintenance in the early and intermediate phases.

Humanitarian Daily Rations (HDRs) should be used to fill any feeding requirements from the time the disaster occurs until the mission is complete. The HDR was created for use in emergency situations to feed and sustain moderately malnourished people until other, more traditional feeding methods are restored. Each ration provides 2,200 calories, costs around four dollars and has a shelf life of three years [Armed Forces Press Service, 2001]. Each ration weighs approximately 30 ounces and can be air-dropped if necessary as it will flutter to the ground [Smith, 2004]. These meals are nutritious, can be eaten by virtually anyone regardless of culture or religion, and are cost effective [Armed Forces Press Service, 2001]. The meals are self-contained and require no special serving or cooking utensils, minimizing the Navy’s need to bring in more gear to cook and serve meals.

While the Humanitarian Daily Ration covers the immediate nutritional needs of most adult men, women, and older children, infants and very young children’s needs are still unmet. For planning purposes, a ration should still be “provided” for each infant and child. This ration should be given to the mother to help meet the extra caloric needs of a lactating woman [World Health Organization, 2004].

Food distribution can have a negative impact on a regional economy, as people will often take the free food and stop purchasing from local suppliers. It is important to communicate with the host nation to determine if rations are needed or desired. Other types of food that may be required can be procured later after a thorough needs assessment.

3. Shelter

Immediately after a disaster occurs, the most important first step is to allow the refugees materials to build themselves shelter with the following minimum standards for floor space [Sphere Project, 2004]:

- 3.5 m^2 per person in hot climates (excluding cooking space which is assumed to be outdoors), or
- 4.5 to 5.5 m^2 per person in cold climates (including cooking space). Increased space requirements accounts for people spending more time in the shelter to protect against the cold environment.

Local supplies and services should be used in the construction of shelter to the maximum extent possible. Only if adequate resources cannot be obtained should additional materials be brought into the area [United Nations High Commissioner for Refugees, 2000]. Assuming the worst case scenario, the area would be completely leveled with no structure remaining in place. For this reason, tents are included in the PUK. Sullivan [1995] recommends the General Purpose (GP) Medium Tent which houses 12 people for hot climates and a ten-man arctic tent for cold climates. This tent is currently the standard used by most U.S. military forces deploying to extremely cold regions [Candler and Freedman, 2001, p. 558].

Tent	Houses	Total Weight	Floor Space (sq/ft)
GP, Medium w/liner	12 military 12 civilian	545	528
Arctic	10 military 4 civilian	76	199

Table 2. Tent Data Relevant to Humanitarian Use [From Headquarters, Department of the Army, Field Manual 55-15, 1997, C-2]

Comparing the two tents to the Sphere minimum space standards, the GP Medium Tent with liner provides approximately 4.05 m^2 floor space for 12 people, which is superior to the 3.5 m^2 of floor space per person required by Project Sphere standards. The arctic tent, however, fails to meet the cold climate per person space requirement. When used to house 10 people, it provides only 1.84 m^2 of floor space per person. Adjusting the tent to house four people yields a floor space of 4.62 m^2, which is consistent with the minimum standard.

In addition to the cold weather tent, the U.S. Army Research, Development, and Engineering Center has developed the Family of Space Heaters. The Space Heater, Arctic (SHA) has been designed to heat the Arctic Ten-Man Tent and other tents with 100 to 200 square feet of floor space. It is 35 pounds and designed to be mobile and easy to assemble [Candler and Freedman, 2001, p. 558]. The stove is capable of using multiple fuels including diesel, JP8, JP5, kerosene, wood and coal. This heater will accompany the 10-Man Arctic Tent for humanitarian operations in cold climates.

The key element to adequate shelter is providing a roof [USAID OFDA, 1998, III-88]. One of the most versatile materials is UV-resistant heavy duty plastic sheeting. This can be used to temporarily repair windows, repair roofs in urban settings and reinforce tents and other emergency shelters [UNHCR, 2000]. Further, plastic sheeting is listed as one of the most common priority needs after disasters in Asia by the Asian Disaster Preparedness Center [ADPC, 2000, Annex D].

Other common shelter requirements on the ADPC priority needs list [2000] include beds and bedding and mosquito netting. The Sphere Handbook [2004, p. 204] minimum standard for bedding states that "people have access to a combination of blankets, bedding or sleeping mats to provide thermal comfort and enable separate sleeping arrangements as required." The military can best meet this standard by providing each person with one each of the following:

- Cot,
- Blanket (climate appropriate),
- Set of Bed linens,
- Pillow, and
- Mosquito netting (in hot climates).

Providing each person with a cot provides a barrier from the ground to protect against losing body heat. An appropriate blanket is included in each version (hot and cold) of the PUK. In hot or humid climates, mosquitoes can quickly spread disease. Mosquito netting helps to protect the population. Many countries will not allow mosquito netting with insecticides. Therefore, non-insecticidal netting is used in the hot-weather PUK.

While these items may seem to be unnecessary for infants, in an emergency situation these items can be used to accommodate their needs until other relief groups arrive on scene with additional supplies. Therefore, all these items will be provided for each infant as well as for each adult.

An important dynamic of populations affected by disasters in Asia is that they do not tend to rely upon evacuation camps, but instead rely upon kinship ties and community networks. They will seek refuge in one-another's homes, watch over children and share food. Camps in these areas are best used for information sharing and as distribution points rather than temporary shelter [ADPC, 2000]. Even though families may not require temporary shelter, communities may become overwhelmed by the additional strain.

Site planning and the establishment of evacuation camps are long-term solutions. This PUK will not address these items as adequate time and planning will be necessary to determine the requirements. Chief of Naval Operations Naval Warfare Publication 3-07 Military Operations Other than War [1998] addresses the material and personnel requirements of long-term missions.

4. Communications

Establishing communications quickly is vital to conducting an effective humanitarian assistance mission. Poor communications result in security risks, uncoordinated relief efforts, inability to relay critical information to relief headquarters and make an already chaotic situation worse [ADPC, 2000].

Even in an age with cell phones and e-mail, after a disaster cell towers and landlines are often heavily damaged or oversaturated. These items may even be unavailable in some nations. Reliable alternatives must be made available for emergency workers. These options should be compatible with civilian communication equipment and easy to use with minimal training by novices.

Effective communication is built into military missions. In fact, it has been said that providing communications is one of the most important contributions the military can make to humanitarian assistance operations [Emerald Express 06-01, 2006, p.16]. Establishing a way to communicate with the Host Nation, Non-Government Organizations and other agencies ensures coordination and unity of effort. Knowing the form of communication typically used by other agencies ensures our actions are visible to others.

The Emerald Express 2006 review of military support in humanitarian assistance and disaster relief highlights two important ways the military can help link to the other players involved: emphasizing web-based communications networks and relying primarily on unclassified information. For example, the Asia-Pacific Area Network (APAN) provided an unclassified, unrestricted access communication network during tsunami relief efforts. By establishing rules for posting early, and keeping the information unclassified and available to all, international coordination and cooperation were greatly enhanced [Emerald Express 06-01, 2006, p. 16].

The key to using an unclassified network effectively is allowing all participants unrestricted access to the website [Emerald Express 06-01, 2006, p.17]. Based on the Emerald Express findings, using the APAN communication network in future disasters in the region should be common procedure, with force protection information being the only element classified. If operating in an area not covered by the APAN network, establishing an unrestricted access website for all agencies involved may prove to be a valuable contribution to the relief effort.

Effective ground communication will vary depending upon the type and location of the disaster. It makes sense to have personnel bring communication gear with them to the region rather than establish items in the PUKs that may or may not be useful. This ensures compatibility with the host nation, that personnel know how to use the equipment and that the equipment is in good working order.

5. Search and Rescue (SAR)

To be effective, search and rescue missions must begin soon after a disaster occurs. The need for search and rescue, life-saving first aid and other immediate medical response is short-lived. According to the Asian Disaster Preparedness Center [2000], external search and rescue teams are commonly used for disasters associated with flooding, such as after a typhoon.

External SAR teams are not usually necessary after an earthquake [ADPC, 2000, Annex D]. The majority of search and rescue after an earthquake is performed within the first 24 hours by the survivors. Since most of the victims rescued suffer from crushing injuries, experience shows that extrications after six hours have a low probability of survival [Demirkinan et al., 2003, p. 247-250].

If the Host Nation requests assistance in their search and rescue effort, the necessary personnel and supplies will need to arrive on location as soon as possible to be immediately employed. The Navy and Marine Corps have personnel who are trained in conducting SAR missions. Rather than assemble SAR supplies in the PUK, units normally tasked with performing humanitarian assistance SAR missions should identify and maintain the necessary items with the unit and develop a concept of operations for humanitarian missions. This will ensure that both the unit and the required gear can deploy at a moments notice.

6. First Aid and Medical Supplies

The World Health Organization (WHO) has developed an Interagency Emergency Health Kit (IEHK) 2006. The IEHK is the third edition of this kit, designed for use in the early phase of an emergency. One kit is designed to support 10,000 people for 3 months. The kit is designed for a displaced population without access to medical facilities [WHO, 2006b].

The kit consists of two modules: a basic supply module and a supplemental unit. The basic supply module is packaged in 10 boxes. Each box is identical and can be separated to serve 1,000 people each. The basic kit contains items otherwise overlooked by military first aid kits, such as Folic acid (for pregnant and lactating women) and Gentian Violet (for treatment of thrush, yeast associated with breastfeeding) in addition to first aid items. The items in this kit are designed to be distributed by people with little medical training and an instruction manual is provided. Optional anti-malaria items are included in the hot-weather version of the PUK.

The supplemental unit contains 14 boxes and is packaged in a manner that allows it to be broken down so that unnecessary items do not need to be sent. It contains items that are useful if trained medical professionals are available. It is also designed to benefit a diverse population, and it contains a midwifery kit and other requirements for pregnant and lactating women.

Since the medical portion of the PUK is developed to support basic first aid medical needs, the basic unit can be broken up to support ten PUKs. The planner can decide if medical personnel will be available and send the supplemental unit only when necessary. The IEHK 2006 is included in the PUK.

7. Clothing

According to the Sphere handbook [2004], the minimum standard for clothing is to provide all women, girls, men and boys with at least one full set of climate and culturally appropriate clothing. In addition, children under two-years old should be provided a blanket at least 100cm X 70cm. Further, “at risk” individuals (the elderly, injured, sick) may need to have additional clothing provided to meet their needs. These standards are intentionally vague and can be interpreted in many ways.

The worst-case scenario dictates that the entire population has an immediate need for clothing. Cultural, religious, and climatic differences mean that enumerated sizes, types, and weights of clothing would need to be available to meet any situation. Clothing must also be gender-appropriate. This element alone can seriously impact the effectiveness of the entire relief effort. Loss of cultural adornments, clothes, head coverings and other forms of traditional dress during crises can, in some societies, affect a woman's identity and restrict her ability to take part in relief programs and attend food distributions [McAskie, 1999]. For example, Muslin women often will not interact with males without a head-covering.

In order to meet Project Sphere minimum standards, it would be necessary to store enumerated types and sizes of clothing. Bringing unacceptable clothing to the region is a waste of time and space. During Tsunami relief, used clothing was often rejected by the recipients who felt demeaned that they should be expected to wear previously worn clothing [Russell, 2005, p. 4]. This is neither cost nor space effective. Clothing items should not be part of this PUK. The response team should wait until requirements can be determined and procure the items locally.

There are many relief organizations that have cost-effective, appropriate clothing in the proper sizes and styles. For example, the United Nations Children's Fund (UNICEF) has a warm clothing kit for children that contains boots, padded jacket, scarf and hat, and mittens in four sizes that costs only twenty U.S. dollars per kit. The number of blankets in the cold-weather PUK will be increased to two and the heated shelters will need to be raised quickly instead of trying to accommodate all types of appropriate clothing. This will keep victims warm while the host nation or other agencies gather the appropriate clothing.

8. Infants

Mortality among infants and children is usually highest at the onset of an emergency when conditions are most threatening. One of the first actions that should be taken by relief workers is identifying households with infants and young children, along with lactating and pregnant women [World Health Organization, 2004]. This action alone can alert the surrounding community to make scarce resources available.

Infants have special requirements to address. The ICRC has developed an infant kit for use in relief operations. The kit contains items for one infant to last one month [ICRC, 2004]:

- Blanket (70 X 95 cm),
- 3 kg of laundry soap,
- 100 g Bar of body soap,
- 250 ml Baby shampoo,
- 250 ml Baby lotion,
- 250 g Baby powder,
- 12 washable diapers (cloth),
- 1 pair plastic pants (diaper cover), and
- 1 thermometer.

The use of disposable diapers is a western concept. In most Asian Pacific regions, disposable diapers are considered a luxury. Infants are often “trained” to eliminate in a specific spot upon cue from their mothers. But since the kit is designed to provide aid in a variety of scenarios, both disposable diapers and cloth diapers should be provided. In addition, several wash cloths are provided for hygiene during diaper changes.

The World Health Organization (WHO) has published numerous documents regarding infant feeding in emergency situations. Foremost among their advice is that artificial milk (also known as infant formula) be avoided whenever possible [Emergency Nutrition Network Online, 1999]. The Infant Feeding in Emergencies [1999] Report states:

> The resources needed for safe artificial feeding - such as water, fuel and adequate quantities of appropriate breast milk substitutes - are usually scarce in emergencies. Artificial feeding in these circumstances increases the risk of diarrhoeal diseases and malnutrition, which in turn substantially increase the risk of infant death. In an emergency, the adequate supply of appropriate food is obviously of fundamental importance. A common belief is that in emergencies it is infants who are at greatest risk of becoming malnourished - but this is not true of breastfed infants. The ability to breastfeed is robust, even in the face of constraints such as reduced maternal dietary intake and psychological stress. There may, however, be occasions where breastfeeding is not an option for some infants and alternatives are required [Emergency Nutrition Network Online, 1999, Introduction].

The first three recommended food sources for infants in the report are breastfeeding, use of a wet nurse (lactating woman) and the use of banked breast milk [ENNO, 1999]. Infant formula is often over-donated by well-meaning humanitarian organizations. Flooding the hospitals and region with infant formula often negatively impacts the host nation’s breastfeeding programs.

While breastfeeding is recommended, the need for infant formula cannot be ignored. Infants who are orphaned or are born to HIV-positive mothers cannot be breastfed. The World Health Organization recommends that infant formulas, if determined necessary, be purchased locally and given in a controlled distribution and supervised area. In these instances, feeding cups and spoons (*not* bottles) should be used [Project Sphere, 2004]. Many women may be unfamiliar about how to properly use the formula which is further exacerbated by a language barrier in preparation instructions [USAID OFDA, 1998, p. III-45]. For these reasons, infant formula will not be included in the PUK.

Infants between the age of six months and two years require complementary feeding. Complementary feeding starts when breast milk alone is no longer sufficient to meet all the nutritional requirements of infants and supplemental foods and liquids must be added to their diet [Dewey, 2001]. These food items are given in conjunction with continued breastfeeding. Consistency of the items offered range from semi-solid, pureed foods in the beginning and gradually progress to finger food and chewable solids as the child ages.

Complementary foods are best accepted when they come from suitable local items familiar to the people and the children. Other food items should be brought in only if no suitable local items are available [World Health Organization, 2004]. For this reason, no complementary food items will be stored in the PUK. These items are better assessed and contracted for (as needed) at the local level. The Navy should consult with nutrition program experts such as the World Health Organization or the United Nations Children's Fund if local foods are unavailable.

We estimate the number of infant kits required in each PUK by looking at the region's birthrate. The Central Intelligence Agency (CIA) maintains a World Factbook [2006] that gives the birthrate per 1,000 people ranked from highest to lowest. Birthrates in the PACOM region range from 17th to 212th. The average birthrate is 21.99 and is distributed about the mean as shown in Figure 9.

The average accounts only for the number of infants from birth to one year old. Given a relatively stable birthrate, we can double this number and assume an average of 44 infants age two years and below per 1,000 population. The planner will need to manually adjust the number of infant kits in the PUK after a disaster occurs. For 2006, the birth rates for nations that are assigned to PACOM along with the estimated number of infants younger than two years old are listed in Appendix B.

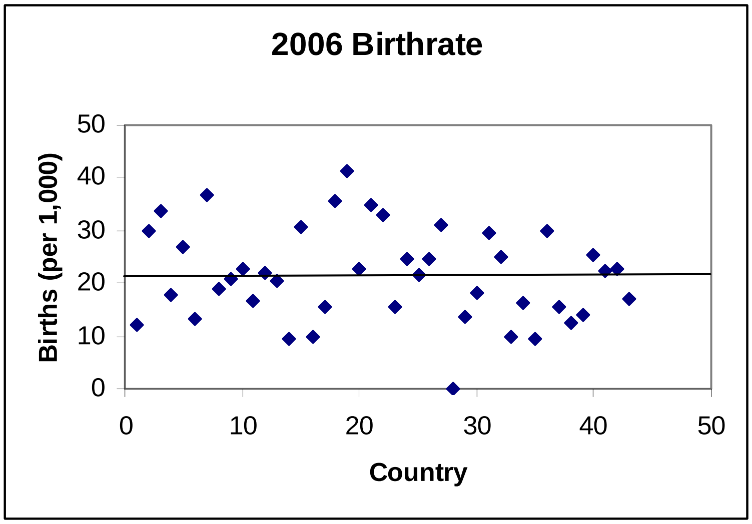

Figure 9: 2006 Number of Births per 1,000 Population for Nations in Pacific Command's Area of Responsibility [After Central Intelligence Agency Factbook, 2006]

9. Electricity and Fuel Requirements

In humanitarian operations, generators are primarily used for cooking, security lighting and water distribution [Sullivan, 1995, p.75]. Sullivan uses an allocation policy based on the use of 60KW generators:

- Functional infrastructure: one for every 1800 people,
- Damaged infrastructure: one for every 900 people, or
- No infrastructure: one for every 450 people.

The PUK relies upon Humanitarian Daily Rations to provide most of the nutrition requirements for the population. This eliminates the need for a generator for cooking purposes. The water purification equipment identified operates on fuel, but requires a 60KW generator as well. Therefore, two generators will meet the electricity requirements of 1,000 people – one generator for the Tactical Water Purification System and one for everything else. A field hospital brought into the area will arrive with the ability to generate power.

Actual transportation equipment to be used in the region will vary depending upon the terrain and other region-specific factors. This PUK does not include these items, but assumes that the receiving unit will provide the necessary equipment to unload and transport the supplies once they arrive in the area.

Fuel consumption rates for common equipment used in humanitarian assistance operations were calculated by Sullivan (1995). Table 3 is a summary of the fuel requirements for items in the PUK with fuel requirements and those of transportation equipment commonly used. Sullivan used the “Yukon 1950” heater model in her thesis. This heater has since been replaced due to safety concerns. The Space Heater, Arctic, which is part of the new Family of Space Heaters (FOSH), is currently being integrated. Since no fuel consumption rate was available, we will assume it is comparable to the Yukon 1950 that it replaced. The fuel requirements for the Tactical Water Purification System (TWPS) are provided by Silbernagel [2006].

Item	Item weight (pounds)	Fuel Usage Rate	Gallons Per	Fuel Type
TWPS	10000	3.5	Hour	Diesel
60KW 400HZ TQC Generator	4153	5	Hour	Diesel
6000 Lb. Rough Terrain Forklift	27100	5	Hour	Diesel
Rough Terrain Container Handler	105120	8.5	Hour	Diesel
5-Ton Truck[1]	22000	0.1243	Mile	Diesel
Space Heater, Arctic	50	0.63	Hour	Diesel[2]

[1] At least one 5-ton truck is required to transport the TWPS.
[2] SHA burns all types of fuel. Diesel is selected to keep a uniform fuel type.

Table 3. Fuel Requirements for PUK Items and Transportation Equipment

Fuel will be made available through organic military assets or by contracting as required. These fuel usage rates can help the planner determine what the fuel requirements are likely to be, based on the equipment being used by the receiving unit.

C. ADVANTAGES OF PRE-POSITIONING THE PUKS

The PUKs are designed to provide immediate relief to disaster victims. Kit benefits diminish as time progresses. Finding locations to store the kit that minimize the distance to areas likely to require future assistance can save lives.

The PUK takes much of the guesswork out of determining urgent needs, which saves planning time. Since all the materials are ready to ship, there is no need wait for orders to be filled. This means that transportation time getting to the region is the fundamental constraint on delivering the aid where it is needed.

There are some potential disadvantages to pre-positioning material. The initial cost outlay of purchasing material to fill the PUK could be prohibitive. In addition, there are holding costs to store the material and potential obsolescence costs for shelf life, particularly with the medical supplies and Humanitarian Daily Rations.

Often the U.S. military's true role in humanitarian assistance operations is to provide distribution capability and manpower for the host nation or NGOs on scene. This is particularly true in cases where the U.S. Navy is asked later in disaster relief to provide assistance. In these circumstances most of the material requirements have been met by other agencies and minimal, known supplies are required to be provided by the Navy.

D. POSSIBLE PRE-POSITIONING LOCATIONS

Many potential storage locations could be identified within Pacific Command's area of responsibility. This necessitates the development of candidate location criteria. These criteria are:

- Strategic geographic location in the region,
- Good relationship with the United States,
- Current agreements for base use in place,
- Amount of established infrastructure, particularly for logistics, and
- Other, location-specific considerations.

First, we identify locations with a strategic position in the region. The COMPACFLT Draft Standard Operating Procedure for HA/DR has been reviewed to learn what USPACOM considers to be its primary Aerial Ports of Departure (APODs). Several other APODs in the region and in continental United States are also identified. This provides an initial list of candidate locations to review for potential use as storage sites.

The most important factors in selecting potential storage locations are the amount of available logistics infrastructure (particularly storage capacity) and the cargo handling capability at the Aerial Ports of Debarkation (APODs). A general review of the Asia-Pacific area reveals that the United States has significant logistics capability in the region. Of particular significance for storage potential are Defense Logistics Agency Defense Distribution Depots and Fleet and Industrial Supply Centers (FISC).

DLA has 26 Defense Distribution Depots worldwide, with several locations in the Asia and Pacific region. These DLA Defense Distribution Depots offer a full range of distribution services to support the Armed Forces [DLA DDC, 2006a]. One of these services offered is the creation of “customized kitting.” The service description on the DLA DDC website states the DDC will “collaborate with customers to create kits of items designed for specific purposes.” There is a cost associated with this service, but the option exists.

In addition to DLA DDCs, the Navy has seven Fleet and Industrial Supply Centers (FISCs) under the direction of Commander, Fleet and Industrial Supply Center. COMFISCUS is responsible for global logistics issues and ensuring best practices are standardized throughout the FISCs.

The FISCs provide “around the clock, worldwide logistics solutions for Navy, Marine Corps, Joint and Allied Forces in support of National Defense Strategies [FISC Yokosuka, 2006].” Warehouse operations under COMFISCUS include kitting and storage for future use or shipment. These functions can be exploited for storing the PUKs.

In addition to storage space, the kits require transportation assets to deliver the material where it is needed. United States Transportation Command (USTRANSCOM) is the Department of Defense distribution owner. Since September 2003, USTRANSCOM has sole control to direct and supervise execution of the strategic distribution system. USTRANSCOM accomplishes its mission using its three component commands: Air Mobility Command, Military Sealift Command and Military Surface Deployment and Distribution Command.

USTRANSCOM’s vision [2006] is to “create and implement world-class global deployment and distribution solutions in support of the President, Secretary of Defense, and Combatant Commander-assigned missions.” As the entity overall responsible for strategic defense distribution, TRANSCOM plays a critical role in the formation of operational plans (OPLANs) in the Joint Operation Planning and Execution System (JOPES). JOPES allows users "to monitor, plan, and execute mobilization, deployment, employment, and sustainment activities associated with joint operations [JCS JP 1-02, 2006b, p. 293].”

Logistics plans are created in JOPES using the Time Phased Force and Deployment Data base (TPFFD). This database contains "time-phased force data, non-unit-related cargo and personnel data, and movement data for the operation plan [JCS JP 1-02, 2006b, p. 546].” USTRANSCOM analyzes strategic sea and air transportation to assist Combatant Commanders in ensuring all operational plans (OPLANS) are feasible.

We assume that the PUKs are being transported in accordance with an established operational plan. Since speed of delivery is considered critical, air transportation is used as the primary means of transportation. Therefore, APOD capacity is another limiting factor on the amount of material that can be stored at a particular location.

For planning purposes, we must determine how much material each region can store and its associated APOD can transport. Locations with a DLA DDC or a FISC are considered to have an unrestricted ability to store and transport the PUKs. The amount of potential storage space is evaluated using three categories for simplicity: small, medium and large. Each category is measured in the maximum “kit-equivalent” units that can be stored. A “kit-equivalent” unit represents the number of hot-weather PUKs that can be stored at a given storage location. While the hot-weather and cold-weather PUKs have different footprints, the number of kits a storage location can store is based solely on the hot-weather PUK. Small means the location has the ability to store the 5 kit-equivalent units, medium is 15, large can store as many of either type of kit as are made available.

The APODs are evaluated using the same small, medium and large criteria. One C-5 has a maximum load of approximately 36 pallets or 70 short tons. A small APOD can load one C-5 per day, a medium APOD 1.5 C-5's and a large APOD 2 C-5's. The planner will not have control as to the type of airframe provided; this measure is used simply because it corresponds to the approximate normal cargo handling capability at each APOD. AMC can authorize overtime or bring in additional cargo-handlers that can increase throughput if necessary, but this will not be considered.

Table 4 depicts the capacity and transportation thresholds for each location considered:

Locations (APOD):	**Storage Space Available**	**Cargo Handling Capacity**
Singapore (Paya Lebar)	**Small**	Medium
Japan (Yokota AFB)	Large	Large
Guam (Andersen AFB)	Large	**Medium**
Diego Garcia	Medium	Medium
Hawaii (Hickam AFB)	Large	**Medium**
Osan, DPRK	Medium	Medium
Sydney, Australia (Richmond RAFB)	Small	Small
Norfolk, VA	Large	Large
San Diego, CA (Travis AFB)	Large	Large

Table 4. Storage Capacity and Cargo Handling Capability for each Location.

A storage location is considered to be small if it can hold five PUK-equivalent units, medium can hold 15 and large can store as many kits of either type as made available. The Cargo Handling Capacity of an Aerial Port of Debarkation is judged by the number of C-5 aircraft that can be loaded in an eight-hour period. Small capacity indicates one aircraft, medium 1.5 aircraft and large two aircraft. The locations whose available storage space and cargo handling capacity do not match are rated at the lowest threshold and given a maximum number of PUK-equivalent units in accordance with the storage capacity categories.

Aside from the logistics and transportation factors, certain locations have more political appeal. Pre-positioning the PUKs in a U.S. owned or well-established location provides the Navy with better control over storage and movement options.

Although one location may demonstrate clear superiority, there may be limits due to a lack of available storage space, transportation, or other factors. This is accounted for by limiting the number of kits allowed to be stored at the location.

1. Singapore

The United States maintains a strong working relationship with the Government of Singapore. In 1990 the U.S. and Singapore signed an Access Memorandum of Understanding to provide the U.S. access to the Naval Base at Sembawang and Paya Lebar Air Base [Garcia, 2001]. The Paya Lebar Air Base is home of the Royal Singapore Air Force Air Logistics Squadron 122 which is comprised of C-130 aircraft.

The country’s strategic location in the region has made it a major hub of U.S. regional logistics. Commander, Logistics Group Western Pacific (COMLOGWESTPAC), based in Singapore, is responsible for Naval logistics throughout the region. In addition, the Naval Regional Contracting Center Singapore, and the Military Sealift Command Office are in close proximity and can easily be called upon when needed. Singapore can accommodate large vessels at Changi Naval Base [Garcia, 2001]. The logistical expertise and robust at-sea logistics capability made COMLOGWESTPAC the ideal choice to become the Navy logistics staging point during Operation Unified Assistance [Bell, 2005].

While Singapore allows the U.S. access to all its bases, the U.S. has no permanent established infrastructure. This limits the amount of storage space for PUKs. A potential delay could be caused by a lack of ground handling capability. During Operation Unified Assistance, Reservists from Cargo Handling Battalion One were called in to load aircraft and ships with relief supplies [Scherman, 2005]. Additionally, coordination with the Government of Singapore would be required before air lift operations could begin.

Singapore’s strategic location could accommodate moving the material via ship if a disaster happens in close proximity to Singapore. This would give the advantage of being able to transport multiple PUKs simultaneously, as storage space on Military Sealift Command ships is far less limited than aircraft.

The primary limitation on storing disaster relief material in Singapore is storage space. For this reason, the number of kits that can potentially be stored in Singapore will be limited to five PUKs, regardless of type. Once the relief effort is underway and timeliness of response is less crucial, Singapore may serve as a logistics staging point as it did during Operation Unified Assistance.

2. Japan

The U.S. military has been operating out of Japan since the end of World War II and our nations maintain good relations. The Navy has established infrastructure in multiple locations, including Fleet and Industrial Supply Center, Yokosuka, Military Sealift Command Far East, Yokohama, and numerous Naval Air Facilities. These (and other) bases provide ample storage location choices as well as access to logistics personnel. Another benefit of placing the PUKs in Japan is that the material is stored close to multiple transportation sources.

Yokosuka, Japan, has several potential storage locations for the PUKs. Yokosuka Naval Base is the United States' largest overseas Naval Base. The Fleet and Industrial Supply Center, Yokosuka, is the U.S. Navy's largest supply facility in the Western Pacific [GlobalSecurity.org, 2006b]. Additionally, Defense Logistics Agency has its largest overseas Defense Distribution Center in Yokosuka [DLA DDC, 2006d]. Yokosuka's primary APOD is Yokota AFB, which has a large cargo handling capability. There are also three additional small APODs (Misawa, Iwakuni, and Fukuoka) in Japan. These robust storage and transportation capabilities enable Japan to store as many PUKs as made available.

3. Guam

Guam has been a territory of the United States since it was ceded in 1897 at the end of the Spanish-American War. Its status as a U.S. territory offers the U.S. Navy the advantage of a forward-deployed base without having to deal with a foreign government. For this reason, the U.S. is currently boosting infrastructure and operations in Guam. Current infrastructure to support logistics operations includes Anderson Air Force Base and several deep-water berths for ships in Apra Harbor [Garcia, 2001]. In addition, Defense Logistics Agency opened Defense Distribution Depot Guam in October 2004.

A potential disadvantage of locating kits in Guam may be its distance from potential disaster sites in comparison to other locations. However, the advantage of operating from a U.S. territory may prevail.

4. Diego Garcia

Diego Garcia is a British territory that is mostly populated by the American military. An agreement between the U.K. and the U.S. in 1966 allows for the mutual use of the island for the defense needs of both nations [MPSRON 2, 2006]. The island is a key strategic location with a full range of facilities and is the last link in the logistics chain to support U.S. and British Naval Forces operating in the Indian Ocean and North Arabian Sea [MPSRON 2, 2006].

The air base at Diego Garcia can accommodate large aircraft but is limited in storage space and inventory management. Cargo handling is also a limiting factor, as the base only has a small staff. For these reasons, Diego Garcia is considered a medium capacity storage location.

5. Democratic People’s Republic of Korea

The U.S. has been operating in the Democratic People’s Republic of Korea (D.P.R.K.) since the end of World War II. While most of the infrastructure here is owned by the U.S. Army, in January 2005, a Memorandum of Understanding between the D.P.R.K. and U.S. Forces Korea was signed to establish Defense Logistics Agency Defense Distribution Depot Korea (DDDK) at Camp Carroll. DDDK is primarily used to enhance physical distribution services to U.S. Armed Forces serving on the Korean Peninsula [DLA DDC, 2006b]. The primary APOD for Seoul is Osan, which is classified as a medium cargo-handling facility.

6. Hawaii

Hawaii provides the second-closest U.S. owned area to Asia and the Pacific Islands and is the headquarters of Commander, U.S. Pacific Command. The only restriction on the amount of inventory that can be held in Hawaii is transportation capacity. Potential inventory managers for the PUKs include FISC Hawaii and DLA Defense Distribution Depot Pearl Harbor. Hawaii offers a medium cargo handling facility at Hickam AFB to provide airlift for the PUKs. A disadvantage of storing PUKs in Hawaii is its distance from the rest of the region.

7. Continental United States (CONUS)

Norfolk, Virginia and San Diego, California are home to the largest in-country naval bases. Both locations have significant Navy presence and a great deal of logistics infrastructure.

Norfolk, VA is home to the world’s largest naval base [GlobalSecurity.org, 2006a]. Aside from the naval base, there is a significant amount of infrastructure in Norfolk to store and transport relief material. Defense Logistics Agency has a Defense Distribution Depot in Norfolk (DDNV). DDNV is already a major stock point for Humanitarian Daily Rations and is often called upon to provide humanitarian relief supplies in the U.S., Caribbean and other nations [DLA DDC, 2006c]. There is also a Fleet and Industrial Supply Center in Norfolk.

San Diego, CA is the homeport for over one-third of the Pacific Fleet. Defense Logistics Agency also has a Defense Distribution Depot in San Diego (DDSD) though it specializes in serving the afloat units and aviation depot level repairables required by Naval Aviation Depot North Island. Commander, Fleet Industrial and Supply Center is headquartered in San Diego. In addition, FISC San Diego handles the requirements for units operating in the area.

Despite the number of possible storage locations directly in San Diego, it is possible that the PUKs will be stored at the San Joaquin Defense Distribution Depot in Northern California. This storage location is preferable as it is closer to Travis AFB, the likely APOD for humanitarian assistance missions.

There are disadvantages to storing the PUKs in the continental United States: In both Norfolk and San Diego, the PUKs will likely be stored at some distance from the transportation sites. Additionally, both sites are far removed from the Asia Pacific region.

8. Australia

Australia is a strong ally and supporter of U.S. presence in the Asia-Pacific region. Our nations have an excellent military-to-military relationship [Garcia, 2001]. However, there is a notable lack of U.S. military established infrastructure in Australia. This entails either renting space from the Australians or requesting to build temporary warehouses. Air Mobility Command flies regularly into Australia and uses the Richmond Royal Air Force facilities [Vanhoosen, 2006]. A potential disadvantage of storing kits in Australia is its extreme southern position in the region.

E. LOCATION MODEL FORMULATION

1. Indices [~Cardinality]

$s \in S$ stockpile, candidate source [~10]
$c \in C$ commodity, type of pack-up kit [~5]
$d \in D$ demand, potential disaster location [~10]

2. Provided Data [units]

$demand_{c,d}$	c-kit demand of potential distaster d [PUK units]
$cost_c$	cost per c-kit [$/PUK unit]
$budget$	maximum cost of PUKs to be pre-positioned [$]
$space_c$	storage space per c-kit [space/PUK unit]
$\underline{space}_s, \overline{space}_s$	minimum, maximum space in candidate stockpile s [space]
$dist_{s,d}$	distance from s to d [proximity]
$\overline{dist}$	large distance, $\overline{dist} > dist_{s,d} \;\; \forall s, d$ [proximity]
$\overline{open}$	maximum stockpiles to select [cardinality]
$\underline{kits}_c, \overline{kits}_c$	minimum, maximum number of c-kits to position [PUK units]

3. Decision Variables [units]

$LOCATE_{c,s}$ pre-positioned c-kits placed at source s [PUK units]
$DELIVER_{c,s,d}$ c-kits from source s to satisfy demand d [PUK units]
$SHORTAGE_{c,d}$ unmet c-kit demand d [PUK units]
$OPEN_s$ equals 1 if stockpile s open, 0 otherwise [binary]

4. Formulation

$$\underset{\substack{LOCATE,\\ DELIVER,\\ SHORTAGE,\\ OPEN}}{\text{MIN}} \quad \sum_{c,s,d} dist_{s,d} DELIVER_{c,s,d} + \overline{dist} \sum_{c,d} SHORTAGE_{c,d} \qquad (0)$$

$$\text{s.t.} \quad \sum_{c,s} cost_c LOCATE_{c,s} \le budget \qquad (1)$$

$$DELIVER_{c,s,d} \le LOCATE_{c,s} \qquad \forall c,s,d \quad (2)$$

$$\sum_{s} DELIVER_{c,s,d} + SHORTAGE_{c,d} \ge demand_{c,d} \qquad \forall c,d \quad (3)$$

$$\sum_{c} space_c LOCATE_{c,s} \le \overline{space}_s OPEN_s \qquad \forall s$$

$$\sum_{c} space_c LOCATE_{c,s} \ge \underline{space}_s OPEN_s \qquad \forall s \quad (4)$$

$$\sum_{s} OPEN_s \le \overline{open} \qquad (5)$$

$$\sum_{s} LOCATE_{c,s} \le \overline{kits}_c \qquad \forall c$$

$$\sum_{s} LOCATE_{c,s} \ge \underline{kits}_c \qquad \forall c \quad (6)$$

$$LOCATE_{c,s} \in Z^+ \qquad \forall c,s$$

$$DELIVER_{c,s,d} \in Z^+ \qquad \forall c,s,d$$

$$SHORTAGE_{c,d} \ge 0 \qquad \forall c,d$$

$$OPEN_s \in \{0,1\} \qquad \forall s \quad (7)$$

5. Discussion

The objective (0) expresses the cost of delivering PUKs from pre-positioned stocks to each potential disaster in units of victim-proximity. Shortages are penalized as if they are supplied by a far-distant source. Constraint (1) limits the total, theater-wide investment in PUK units. Each constraint (2) limits deliveries to those units pre-positioned at some stockpile. Each constraint (3) requires that demand for a disaster be met by some delivery plan, or that a shortage be signaled. Each constraint (4) either limits storage space of inventory at an open stockpile to the maximum capacity of that stockpile, or forces minimum space utilization of a stockpile, given that it is open. Constraint (5) limits the number of stockpiles that can be open. Each constraint (6) stipulates a maximum number of PUKs to position, or a minimum. Stipulations (7) define variable domains, where Z^+ denotes the set of non-negative integers.

6. Implementation

The location model has been implemented in the Generalized Algebraic Modeling System (GAMS) and solved with the integer linear program package CPLEX [GAMS, 2006]. Each disaster scenario is considered a separate instance from the other scenarios, not an aggregate need to outfit all disasters simultaneously.

Distance between a PUK stockpile and a disaster scenario ($dist_{s,d}$) is measured using nautical-miles. This distance could also be measured in flight hours, total delivery time (including load and offload), or any other function that captures the logistic distance or delay from a storage location to a disaster site. Changing this function will either centralize or disperse the favored storage location(s) depending on whether the function is superlinear or sublinear with respect to our baseline using nautical miles.

Ten disaster scenarios are created, each of varying severity and type. A summary of the disaster scenarios is shown in Table 5.

Place:	**Disaster:**	**Population Affected:**	**LAT**		**LONG**		**Climate:**
Wonosobo, Indonesia	Earthquake	10,000	7° 21'	S	109° 53'	E	Hot
Baranguay, Philippines	Landslide	3,300	10° 17'	N	125° 07'	E	Hot
Dinajpur, Bangladesh	Flash Flood	100,000	25° 37'	N	88° 38'	E	Hot
Latur region of India	Earthquake	30,000	18° 24'	N	76° 34'	E	Hot
Bangkok, Thailand	Tropical Storm	5,000	13° 43'	N	100° 30'	E	Hot
Indonesia: Guntur volcano	Volcanic erupt	5,000	7° 08'	S	107° 50'	E	Hot
Fukuoka, Japan	Earthquake	3,500	33° 35'	N	130° 24'	E	Cold
Gampaha, Sri Lanka	Flooding	145,000	7° 06'	N	80° 00'	E	Hot
Nepal/India Border	Earthquake	10,000	27° 29'	N	82° 47'	E	Cold
Artyom, Russia	Earthquake	4,000	43° 23'	N	132° 17'	E	Cold

Table 5. Disaster Scenarios Created for the Model

The disaster scenarios are fictional, although they resemble similar disasters in the region based on the World Health Organization’s Emergency Disasters Database [World

Health Organization, 2006a]. The population affected represents the total number of people in need of humanitarian assistance. This number is not broken down by demographics. Once the location is determined, it is up to the planner to manually adjust the exact contents of the kit to accommodate the specific demographics of the disaster. The number of kits needed is the affected population divided by 1,000.

Candidate storage locations are identified by the Aerial Port of Debarkation from which the kits will be transported. The APODs and their geographic location are listed in Table 6.

APOD Locations:	**LAT**	**LONG**
Singapore (Paya Lebar)	1° 27' N	103° 49' E
Japan (Yokota AFB)	35° 17' N	139° 40' E
Guam (Andersen AFB)	13° 35' N	144° 55' E
Diego Garcia	7° 20' S	72° 25' E
Hawaii (Hickam AFB)	21° 21' N	157° 58' W
DPRK (Osan)	35° 08' N	128° 38' E
Sydney, Australia (Richmond RAFB)	33° 52' S	151° 12' E
Norfolk, VA	36° 50' N	76° 17' W
San Diego, CA (Travis AFB)	32° 42' N	117° 09' W

Table 6. Aerial Ports of Debarkation for the Candidate Storage Locations

There is a limit on the amount of material that realistically can be set aside. Large inventories take up excessive space and the cost becomes prohibitive. In addition, these PUKs will require assets for transportation, manpower for distribution, and may have portions subject to spoilage (e.g., the medical kit and Humanitarian Daily Rations). The cost of kits created will need to stay within a specified dollar budget. This budget represents only the money to purchase the PUKs, and does not include transportation or storage costs.

We demonstrate our model for the following instances, ranging from least to most restrictive:

- Unlimited capacity and unlimited budget;
- Unlimited budget with increasingly limited capacity;
- Unlimited capacity with increasingly limited budget; and
- Limited Budget and limited capacity – with and without some key locations forced open.

7. Findings

We start with an “infinite” budget ($500M) and an unlimited capacity to find the single, best location: we (i.e., our model) select Singapore. Each disaster is covered, and 10 cold-weather and 145 hot-weather PUKs are procured. These numbers represent the largest disaster of each climate category, and thus ensure no shortage for any disaster scenario regardless of climate. The total cost of these kits is $135.8M.

The logistics proximity objective can be further reduced by allowing additional locations. While there is no formal restriction to choose the best k+1 storage locations that include the best k already found, we encounter this phenomenon. The successive new locations are used to store PUKs closer to some scenarios, while leaving an adequate number of kits to cover the scenarios closer to the storage sites already chosen. For example, with two storage sites, Singapore retains 10 cold-weather PUKs but stores only 100 hot-weather PUKs. Diego Garcia stores 145 hot PUKs – enough to supply the largest disaster closest to it.

The best logistic proximity solution is achieved by using four storage locations. Table 7 shows these locations, along with the decrease in nautical miles associated with each site addition, the total cost with the additional storage location and the number of each type of PUK procured. With no budget limit or capacity restrictions, four locations cost $228.8M.

Disaster:	**Singapore**	**Diego Garcia**	**Osan DPRK**	**Guam**
Java Indonesia	607			
Baranguay Philippines	1377			1180
Dinajpur Bangladesh	1696			
Latur India	1900	30		
Bangkok Thailand	762			
Guntur Indonesia	554			
Fukuoka Japan	2440		268	
Gampaha Sri Lanka	1465	145		
India Nepal Border	1977			
Artyom Russia	2942		449	
Victim K-Nautical-Miles:	15720	12530	7865	7668
Cost (in millions):	$135.8	$219.8	$225.4	$228.8
Total Hot-weather PUKs	145	245	245	249
Total Cold-weather PUKs	10	10	14	14

Table 7. Results from the Unlimited Budget, Unlimited Capacity Scenario

The top row of the table lists, from left to right, the successive storage location selected as more storage sites are allowed. The columns represent the change in thousand victim-nautical-miles by storing the total PUKs shown in the last two rows. The greatest change in victim-nautical miles is achieved with the addition of the third location in Osan DPRK. The fourth storage location in Guam presents only a marginal decrease in victim-nautical-miles saved. More than four locations lends no additional improvement.

Next, we allow an unlimited budget while uniformly decreasing the amount of per-location storage space available at each location. The first change from the unlimited capacity scenario appears when storage space is reduced to 160 units per location. This is the number of space units required to store enough hot and cold-weather PUKs to meet the total demand generated by the largest disaster in each category.

Singapore remains the single best storage location. The amount of storage space does impact the number of kits and the types stored. The first response as a consequence of reducing space is to decrease the number of cold weather PUKs to meet the second-largest cold-weather disaster. This is reasonable because there are fewer disasters requiring cold-weather PUKs and each cold-weather kit requires more storage space.

As the maximum per-site storage space available is decreased, the model attempts to use the same storage plan as unveiled in the unlimited scenario. For example, when the maximum storage space available is limited to 150 units, Singapore is selected as the single best storage location, with 4 cold-weather and 144 hot-weather PUKs. When two or more locations are chosen, the results are identical to those produced by the unlimited scenario for two or more locations, with 100 hot-weather PUKs and 10 cold-weather PUKs in Singapore and 145 hot PUKs in Diego Garcia. This trend continues until the maximum per-site storage capacity is limited to 100 units. At this point, Osan is given all the cold-weather PUKs. Continuing to reduce the amount of storage space forces the model to open more and more storage locations in an attempt to avoid shortage costs. As before, the k+1 best choices include the k best already found. Locations are opened in the following order:

- Singapore,
- Diego Garcia,
- Osan, Democratic People's Republic of Korea (DPRK),
- Guam,
- Yokota, Japan,
- Sydney, Australia,
- Pearl Harbor, Hawaii,
- Norfolk, Virginia, and
- San Diego, California.

We now assess the effect of budget changes on storage location choice. For these model runs, storage capacity is unlimited and uniform among the storage locations. Once again, Singapore is always selected as the best, single storage location for all budget values.

The scenario begins by selecting the same four storage locations chosen by the unrestricted model. The number of storage locations that can be opened becomes increasingly restricted as the budget to purchase additional units is decreased. Dropping a storage location is always preceded by a reduction in the number of cold-weather PUKs. The cold-weather PUK is more expensive than the hot-weather one. The order in which storage locations are opened does not change as budget decreases.

In all three of these scenarios, Singapore is always the single, best location. Osan is the location of choice for the cold-weather kits. Finally, the order in which storage locations are selected is the same throughout these scenarios.

We now restrict the solution by both budget and storage space available. We set an arbitrary budget of $50M. Each storage location is given a maximum storage capacity based upon its logistics infrastructure. The results are shown in Table 8.

Storage Location Selection Order	Location Selected	Cold	Hot	Cost (Mil $)
First	Yokota Japan	0	30	25.2
Second	Yokota Japan	3	26	
	Diego Garcia	0	15	38.64
Third	Yokota Japan	2	26	
	Diego Garcia	0	15	
	Osan, DPRK	0	15	49.84
Fourth	Yokota Japan	2	21	
	Diego Garcia	0	15	
	Osan, DPRK	0	15	
	Singapore	0	5	49.84

Table 8. Model Results Using a Budget of $50M and Maximum Capacities from Table 4.

This table summarizes the decisions made when the model is given a budget of $50M and each storage location is restricted in size based on the evaluation shown in Table 4. For the first time, Singapore is not selected as the single best storage location. This is because the location with the most storage space is selected to avoid shortage penalties. By the fourth selection, the model has spent all the available budget and is now shifting PUKs around to further minimize victim-nautical-miles. We have a fixed number of PUKs and are merely shuffling these closer to potential demands.

The first location selected is Yokota, Japan. This is the closest storage location with the most capacity. The budget limit is reached after opening a third storage location. After this, the model can only shift the location of units to achieve a lower minimum victim-nautical miles. The fourth storage location of choice is Singapore.

Guam has been a focal point of U.S. operations in the Pacific. To examine Guam's potential as a "single storage source" for PUKs, Guam is individually fixed open while the model is free to choose amongst all other locations after using Guam. We then fix open Yokota, Japan, and then Singapore. Forcing Guam to provide relief supplies does not inflict a large penalty in victim-nautical-miles transported in comparison to Yokota. However, Guam and Yokota are both significantly worse than Singapore. Every model run eventually opens Singapore.

	Single Location Open:		
Disaster:	**Yokota**	**Guam**	**Singapore**
Java Indonesia	30.4	24.2	6.1
Baranguay Philippines	6.9	4.7	5.5
Dinajpur Bangladesh	39.9	48.6	25.4
Latur India	51.8	59	28.5
Bangkok Thailand	12.4	12.9	3.8
Guntur Indonesia	15.6	12.6	2.8
Fukuoka Japan			
Gampaha Sri Lanka	55	57.7	21.9
India Nepal Border			
Artyom Russia			
Victim K-Nautical-Miles:	212	219.7	94

Table 9. Results of Respectively Forcing Yokota, Guam and Singapore Open with a Capacity of 15 Units

The model is run three separate times forcing open Yokota, Guam, and Singapore, respectively. Each of these storage locations is given a maximum storage capacity of 15 PUKs in order to compare similar total victim-nautical-mile results. While Guam and Yokota do not differ by a large margin, there is a significant difference between the two and Singapore. All the locations store only hot-weather PUKs.

In restricted model runs, the cold-weather scenarios are often ignored to meet the needs of the hot-weather scenarios. This is because the hot-weather kit costs less and requires less storage space. Looking at the aggregate of the runs, Osan, D.P.R.K., is the storage location most often selected to store cold-weather kits.

IV. CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY

The Humanitarian Assistance pack-up kit (HA PUK) identifies items of critical importance for use after a disaster. The kit contents also offer a standardized list of material to provide to those on scene to communicate exactly what they have available to them. The PUK is meant to meet urgent requirements while additional data on the situation is being collected. Each kit is designed to provide the basic items required by 1,000 people for 14 days. A hot and cold-weather version of the PUK is created to better meet the specific requirements of a given climate.

Pre-positioning the kits in the region aims to hasten the delivery of aid to those who need it. Candidate locations have been identified and an optimization model used to determine the best location plan to facilitate movement in the region. Running an unrestricted model, we find that Singapore is consistently selected as the single best storage location.

An incremental, uniform reduction of the maximum storage capacity eventually results in opening all the storage locations in the following order: Singapore, Diego Garcia, Osan, Guam, Yokota, Sydney, Pearl Harbor, Norfolk and San Diego. Reducing the budget has the opposite effect, and the number of storage locations opened is reduced until only Singapore remains open. Additionally, as space and budget are reduced, hot-weather PUKs are preferred over cold-weather PUKs.

The addition of “real world” storage limitations and budget restrictions yields Yokota, Japan, as the single best storage location. This is because Yokota is given a large storage capacity, and the model looks to avoid shortage penalties. Guam is almost as good a location as Yokota and its use has benefits not accounted for in our model. Each location, if individually considered, is about twice worse than Singapore. Increasing the storage capacity at Singapore would substantially decrease the time it takes to transport the PUKs to the affected population. Singapore is the storage location of choice for hot-weather PUKs. Osan, D.P.R.K., is the best location for cold-weather PUKs.

B. RECOMMENDATIONS FOR FUTURE STUDY

We assume that storage, obsolescence and transportation costs are not an issue, and that speed of response is the driving factor behind the items included in the PUK, and where their pre-positioning. These assumptions provide the flexibility to examine a range of potential relief material, as well as storage locations. Further research should be done to determine if there are cost-effective alternatives to the recommended items in this thesis.

There is currently no operational plan for transportation and distribution of the PUK developed in this thesis. We work under the assumption that a plan is in place and transportation time is the only measure of merit to move the kits from their storage locations to the general area of the disaster. The material in the kit is only useful if it can be conveyed quickly to the people who need it. The assets required to deliver the material will depend on the terrain, remaining infrastructure, and other factors too numerous to include in this thesis. Potential delivery plans and a general concept of operation should be created to address the offload, personnel and transportation capabilities required to support a variety of disaster scenarios.

Often our presence in an area is the most important benefit the United States Armed Forces can provide. Military transportation capability often proves to be invaluable to relief operations since many NGOs do not have the assets to get aid to those in need. The prevailing philosophy of humanitarian operations should be to do the most good.

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APPENDIX A. COUNTRIES AND ENTITIES OF THE ASIA PACIFIC REGION

Australia	Mauritius
Bangladesh	Micronesia, Federated States of
Bhutan	Mongolia
Burma (Myanmar)	Nauru
Cambodia	Nepal
China	Niue
Comoros	New Zealand
Brunei	Palau, Republic of
Cook Islands	Papua New Guinea
Fiji	Philippines
New Caledonia/French Polynesia (France)	Russia
India	Samoa
Indonesia	Singapore
Japan	Solomon Islands
Kiribati	Sri Lanka
Korea, Republic of	Taiwan
Korea, North	Thailand
Laos	Tonga
Madagascar	Tuvalu
Malaysia	Vanuatu
Maldives	Vietnam
Marshall Islands, Republic of	

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APPENDIX B. BIRTHS PER 1,000 POPULATION AND ESTIMATED INFANT POPULATION

Country	Births per 1000	World Rank	Infants(< 2) per 1000 population
Australia	12.14	173	24.28
Bangladesh	29.8	57	59.6
Bhutan	33.65	46	67.3
Burma (Myanmar)	17.91	125	35.82
Cambodia	26.9	69	53.8
China	13.25	165	26.5
Comoros	36.93	33	73.86
Brunei	18.79	113	37.58
Cook Islands	21	100	42
Fiji	22.55	88	45.1
New Caledonia/French Polynesia (France)	16.68	134	33.36
India	22.01	93	44.02
Indonesia	20.34	107	40.68
Japan	9.37	211	18.74
Kiribati	30.65	53	61.3
Korea, Republic of	10	203	20
Korea, North	15.54	144	31.08
Laos	35.49	38	70.98
Madagascar	41.41	17	82.82
Malaysia	22.86	85	45.72
Maldives	34.81	41	69.62
Marshall Islands, Republic of	33.05	47	66.10
Mauritius	15.43	147	30.86
Micronesia, Federated States of	24.68	78	49.36
Mongolia	21.59	98	43.18
Nauru	24.76	76	49.52
Nepal	30.98	52	61.96
Niue	N/A	N/A	N/A
New Zealand	13.76	161	27.52
Palau, Republic of	18.03	121	36.06
Papua New Guinea	29.36	59	58.72
Philippines	24.89	74	49.78
Russia	9.95	204	19.90
Samoa	16.43	137	32.86
Singapore	9.34	212	18.68
Solomon Islands	30.01	55	60.02
Sri Lanka	15.51	146	31.02
Taiwan	12.56	172	25.12
Thailand	13.87	160	27.74
Tonga	25.37	73	50.74
Tuvalu	22.18	91	44.36
Vanuatu	22.72	87	45.44
Vietnam	16.86	132	33.72

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APPENDIX C. CONTENTS OF THE PACK-UP KIT

Nomenclature	NSN	per kit	Weight per Unit	Total Wt per Kit (short-tons)	Cost (in $ K)	Planning Factor
Water - Common Items all Climates						
Tactical Water Purification System	4610-01-488-6961	1	5.00	5.00	$ 337.0	1 per 1000 people
TWPS Ocean Intake Structure System Module	specifications not available. (negligible weight added)				negligible	1 per 1000 people
TWPS Cleaning Waste Module	specifications not available. (negligible weight added)				negligible	1 per 1000 people
60 KW 400HZ TQG Generator	6115-01-274-7395	2	2.10	4.20	$ 57.0	2 per 1000 people
Cubitainer - 5 Gallon (36/BX)	7310-00-128-6837	28	0.01	0.28	$ 3.0	1 per person
TOTALS:				**9.48**	**$ 397.0**	
Sanitation - All Climates						
Latrine: Grey Privacy Tent (EA)	4510-01-382-4315	50	0.004	0.20	$ 4.2	1 per 20 people
Latrine: Commode, Field (EA)	4510-01-382-4289	50	0.015	0.75	$ 14.6	1 per 20 people (each commode includes daily restroom kit for 20 people/3 days)
Latrine: Restroom kit, disp (100/BX)	4510-01-379-0190	150	0.020	3.00	$ 63.0	toilet paper, towelette and bags for 20 people/5 days
Latrine: Can, waste receptacle, 32 gallon with lid (EA)	7240-00-819-7735	60	0.015	0.90	$ 2.1	1 per latrine and 1 per 100 people
Trash bags [125/BX]	8105-01-183-9769	224	0.009	2.02	$ 8.1	1/person/day and 20/latrine/day
16 quart bucket (laundry)	unavail	100	0.001	0.10	$ 1.0	1 per 10 people
Laundry soap (PK/24)	7930-01-312-6389	42	0.015	0.63	$ 1.4	1 per person
TOTALS:				**6.87**	**$ 94.4**	

Nomenclature	NSN	per kit:	Weight per Unit	Total Wt per Kit (short-tons)	Cost (in $ K)	Planning Factor
Shelter - Common Items all Climates						
Blanket, Bed 66" x 84" (BX/12)	7210-00-054-7911	84	0.002	0.17	$ 8.2	1 per person
Plastic Sheeting	USAID PLASTIC SHEETING (RL - 24'x100')	10	0.064	0.64	negligible	*includes 6 rolls of tape per box *plan factor: 12'x20' per 10 people (100 people/roll)
Cot (EA)	7105-00-935-0422	1000	0.01	10.00	$ 62.0	1 per person
Pillow (EA)	7210-01-376-5194	1000	0.001	1.00	$ 10.0	1 per person
Pillow case (DZ)	7210-01-219-8618	84	0.005	0.42	$ 3.2	1 per person
Sheet, Bed (DZ)	7210-01-220-1485	84	0.026	2.18	$ 22.1	1 per person
TOTALS:				**14.41**	**$ 105.5**	
Subsistence - All Climates						
Humanitarian Daily Ration (BX/10)	8970-01-375-0516	14000	0.013	17.50	$ 62.3	1 per person per day
TOTALS:				**17.50**	**$ 62.3**	
Medical - All Climates						
WHO Interagency Emergency Health Kit - Basic Unit	N/A	1	0.048	0.05	negligible	1 per 1000 people (10 come to a kit)
WHO Interagency Emergency Health Kit - Supplemental Unit	N/A	1	0.502	0.50	$ 5.0	1 per 10,000 people (~ 5K for an entire IEHK of Basic and Supplemental items)
Blanket, Casualty (BX/288) Priced EA	7210-00-935-6666	2	0.024	0.05	$ 2.9	as required
TOTALS:				**0.60**	**$ 7.9**	

	Nomenclature	NSN	per kit:	Weight per Unit	Total Wt per Kit (short-tons)	Cost (in $ K)	Planning Factor
Mortuary - All Climates							
*	Pouch, Human Remains (black)	unavail.	500	0.004	2.00	$ 18.0	*Color choice depends on local custom 500 provided in the Mortuary section. If more are required they can be ordered later.
*	Pouch, Human Remains (white) (PG/20)	9930-01-357-5436	25	0.08	2.00	$ 18.0	
*	Pouch, Human Remains (opaque) - EA	9330-01-331-6244	500	0.004	2.00	$ 18.0	
	Camera, digital package Fuji F470 (Best Buy)	Open Purchase	1	5E-04	0.00	$ 0.2	
	Photo printer, digital Canon Selphy Compact photo (Best Buy)	Open Purchase	1	0.003	0.00	$ 0.2	Note: PUK does not include necessary DD Forms for mortuary affairs. Consult JP 4-06.
	Digital Camera memory cards SanDisk 1GB (Best Buy)	Open Purchase	1	5E-04	0.00	$ 0.1	
	Gowns (12/PG)	6532-00-083-6535	25	0.009	0.23	$ 0.2	300 per kit
	Goggles (100/PG)	6540-01-290-1157	3	0.002	0.01	$ 0.5	300 per kit
	Gloves (100/PG)	6515-01-454-4784	3	0.002	0.01	$ 0.1	300 per kit
	Masks, surgical (300/PG - 50/BX)	6532-00-247-9753	1	0.001	0.00	$ 0.1	300 per kit
	TOTALS:				**6.24**	**$ 55.4**	
Hygiene Kit							1 kit per person
	Toothbrush (144 BX)	8530-01-293-1388	7	0.003	0.02	$ 0.3	1 per hygiene kit
	Toothpaste (12 PG)	8520-01-303-4037	84	0.002	0.13	$ 1.0	1 per hygiene kit
	comb (144 BX)	8530-01-293-1384	7	0.004	0.03	$ 0.4	1 per hygiene kit
	soap, toilet 5 oz (100 BX)	8520-00-531-6484	10	0.016	0.16	$ 0.4	1 per hygiene kit
	soap dish (12 PG)	8530-01-371-0055	84	0.001	0.04	$ 0.6	1 per hygiene kit
	shampoo (15 oz Suave)	unavail	1000	0.001	0.60	$ 1.5	1 per hygiene kit
	pad, sanitary (feminine hygiene) 28 pack always	unavail	1000	0.001	0.52	$ 7.8	1 per hygiene kit
	razor (720 BX)	8530-01-347-9576	3	0.006	0.02	$ 0.2	2 per hygiene kit
	deodorant, personal (12 CS)	3209HG	84	0.002	0.13	$ 0.3	1 per hygiene kit
	Towel (DZ)	7210-01-417-9681	84	0.001	0.04	$ 8.4	1 per hygiene kit
	Washcloth (DZ)	7210-00-718-8325	167	0.006	1.00	$ 1.5	2 per hygiene kit
	TOTALS:				**2.68**	**$ 22.4**	

Nomenclature	NSN	per kit:	Weight per Unit	Total Wt per Kit (short-tons)	Cost (in K)		Planning Factor
Infant Kit							1 kit per infant (44 per PUK)
Baby powder, cornstarch (12 BX)	8510-01-519-7739	3	0.006	0.02	$	0.1	1 per infant kit
Baby lotion (12 BX)	8510-00-347-2342	3	0.002	0.01	$	0.2	1 per infant kit
Baby soap - Johnson's baby bar (3 oz bar)	unavail	44	0.000	0.00	$	0.2	1 per infant kit
Baby shampoo (24 BX)	8520-01-149-4129	2	0.007	0.01	$	0.2	1 per infant kit
Washcloth (DZ)	7210-00-718-8325	15	0.006	0.09	$	0.1	4 per infant kit
Cloth diapers (PG/300)	6532-01-127-2213	528	0.024	0.04	$	1.0	12 per infant kit - 47 lbs for PG of 300
Disposable diapers (136/PG) size: Medium 12-24 lbs	6532-01-522-8052	44	0.005	0.22	$	1.1	8/infant/day (used 1 PG of 136 each kit)
Pins, safety (PG/144)	6530-01-525-4393	8	0.001	0.00	$	0.1	24 per infant kit
Gerber vinyl pants (size 9/18 mths) (PK/3)	unavail	132	0.000	0.03	$	1.2	3 per infant kit
Gerber soft bite (baby spoon)(PG/6)	unavail	8	0.002	0.02	$	0.1	2 per infant kit (use for sup. feed)
Gerber bowls (PK/4)	unavail	11	0.001	0.01	$	0.1	2 per infant kit (use for sup. feed)
Ivory Snow Laundry detergent powder, 15 loads, 24 oz	unavail	44	0.001	0.04	$	0.3	1 box per infant kit
blanket, baby (PG/12)	7210-01-204-2641	8	0.004	0.03	$	0.5	2 per infant kit
Gown, infant (PG/500**)	6532-01-366-3201	88	0.000	0.01	$	0.1	2 per infant kit **1 package is enough for apx 5 1/2 kits (.22 lbs/gown)
Infant: cap, knit (100 Blue/100 Pink)	8450-01-314-2633	1	0.000	0.02	$	0.1	2 per infant kit ~ 1 pink and 1 blue (200 = 10 lbs)
TOTALS:				**0.55**	**$**	**5.4**	

Nomenclature	NSN	per kit:	Weight per Unit	Total Wt per Kit (short-tons)	Cost (in K)	Planning Factor
Cold Weather Specific						
Tent, Arctic, 10-Man	8340-00-262-3684	250	0.038	9.50	$ 484.0	1 per 4 people
Space Heater, Arctic	4520-01-444-2375	250	0.025	6.25	$ 175.0	1 per Arctic tent
TWPS Cold Weather Module	specifications not available. (negligible weight added)				negligible	1 per kit
Blanket, Casualty (288/BX) priced EA	7210-00-935-6666	4	0.024	0.09	$ 6.0	1 per person
TOTALS:				**15.84**	**$ 665.0**	
Hot Weather Specific						
Tent, GP, Medium with Liner	8340-01-455-8947	84	0.273	22.89	$ 110.0	1 per 12 people
Insect Net Protector	7210-00-266-9740	1000	0.001	0.50	$ 29.0	1 per person
Rain poncho, one-size	8405-01-100-0976	1000	0.001	0.90	$ 49.0	1 per person
WHO IEHK (2006) Anti-malarial unit (accompanies the basic unit as required)	N/A	1	0.018	0.02	$ -	1 per 1000 people (10 come to a kit - cost is part of the overall IEHK price)
Shoes, Shower (L) (72/PK)	6532-01-469-7520	14	0.003	0.04	$ 1.0	1 set per person
TOTALS:				**24.35**	**$ 189.0**	

Hot-Weather Kit Total Weight and Price[1]	**83**	$ 939
Cold-Weather Kit Total Weight and Price[2]	**74**	$ 1,415

[1] While the cold weather kit weighs less, it has three times as many tents to store, as well as bulkier items that require more storage space be made available

[2] One cold or hot-weather PUK will have the following transportation asset requirements (per airframe) based solely on weight:

		Number of sorties	
Aircraft	Max Tons	Cold-PUK	Hot-PUK
C-5	70	2	2
C-130	10	8	9
C-17	32	3	3
B-747	90	1	1

Note: The items listed are representations of what should be included in these PUKs. Alternate NSNs may be available. Costs and weights are approximated and subject to change.

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